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POWER AND INFLUENCE IN THE MODERN STATE

THE autobiography which Lord Beveridge published last year under the title "Power and Influence"* is, like that of Lord Reith published earlier†, of historical interest. Both books fail to throw as much light as might have been expected on the developments with which their authors are most closely and enduringly associated: Reith, because his greatest achievement was to him of little interest compared with his brief career in ministerial office; Beveridge, in part, because the origins of the Beveridge Report were left to be told more fully in Lady Beveridge's subsequent book. They are, of course, authoritative in their particular fields, but through them both runs a note of disappointment and frustration. While this may sometimes lead the reader to ask questions about our ability to make use of talent, it also induces reflexions on the theme around which Beveridge in particular has written his book, and indeed about the whole nature of government, the way it works, the limits of autocracy and democracy, the place of the expert in democracy, the efficacy of discussion and persuasion and the adaptation of society to the new powers and influences to which it is subjected by technological change. It is not the frustration, which Reith and Beveridge are inclined to take tragically, that leaves the dominant impression, but the deeper issues that are opened up by the title Lord Beveridge chose for his book, and that lie at the root of the functioning of democracy in a world in which such immense concentrations of power are possible. To the questions of leadership in the modern State, the source of power and the process of influence, Lord Beveridge's book is highly relevant, and it may be surmised that if either he or Lord Reith were induced to lecture on leadership, they might contribute some dicta at variance with those hitherto enunciated in the Walker Trust Lectures.

The conceptions of leadership which find expression in these two books, to some extent complementary, are indeed imperfect or incomplete. Lord Beveridge does not seem to appreciate how closely this question of leadership is related to his theme. Power, as he uses the word, means ability to give to other men orders enforceable by sanctions, punishment or control of rewards, and—especially the power of government—the making and enforcing of laws, using the instrument of fear. He recognizes that if power is to be used for good, it must be guided by reason and accompanied by respect for other men, and that in any advanced society there is also the power of money, working through self-interest—greed rather than fear. By influence, on the other hand, he means changing the actions of others by persuasion and by appealing to reason or to emotions other than fear or greed; and to him the instruments of influence are words, spoken or written, while for influence to be

* "Power and Influence". By Lord Beveridge. (London: Hodder and Stoughton, 1953.) 30*s*.

† "Into the Wind". By Lord Reith. (London: Hodder and Stoughton, 1949.) 25*s*.

for good it must rest on knowledge. Influence, in fact, is set in antithesis to power as the alternative means of getting things done. They are not seen as complementary. Influence, it is true, is not government, but Lord Beveridge suggests that the pursuit and exercise of power do not consort naturally with the pursuit of knowledge or the appeal to reason.

Power as a means of getting things done appeals to that which men share with the animals, to fear and to greed; it leads those who wield it to desire it for its own sake, not for the service it may render, and to seek its continuance in their own hands. Influence, on the other hand, he argues, as a means of getting things done, appeals to that which distinguishes men from animals; and the way out of the world's troubles to-day is to treat men as men, to enthrone influence over power, and to make power revocable. It is no longer more knowledge that the world chiefly needs: power is now in the hands of men whose intentions, by any standard of respect for humanity, justice and freedom, are suspect.

Although Lord Beveridge considers the heart of the world's problem to-day is to find the right means of controlling the exercise of power and securing a place for influence, and asks some pertinent questions about democracy and the exercise of power in a democracy by particular groups, his antithesis between power and influence seems to lead him astray. It was one of his own staff at the London School of Economics who laid it down as a principle of legislation that the channels of assent could not be dug too deep, and the problem of the responsible exercise of power turns in part on this question of assent or persuasion and discussion.

Even more, it turns on personality, and this factor Lord Beveridge tends to discount or ignore. When he writes, "to use on administration the time of a great teacher or researcher is misuse of rare faculties; it is misuse which men of the highest gifts as a rule take care to avoid", he is directing attention to a danger to which scientists at least, as Sir Cyril Hinshelwood's address at the British Association meeting in Edinburgh testified, are increasingly conscious. But it is only one side of the truth. Harm and waste would equally result if no such men brought to the task of administration the imaginative insight which only their genius can confer. Government is more than administration, and administration is something more than the mechanical organization of work, the breaking up of complex tasks into simple processes, the assignment of responsibility and the provision of means for accomplishing the task assigned, to which Lord Beveridge appears to limit his conception.

In this mechanical aspect of administration Lord Beveridge himself excelled; but the government or leadership of men demands also something else, which John Buchan expressed so admirably in his lecture on Montrose and leadership and which, more prosaically, is embodied in Lieutenant-Commander A. H. Leighton's principles for the governing of men. This communication of purpose, this vision or contagion of greatness is the essence of leadership, and it springs from that indefinable personality in which Lord Beveridge is not interested as such, for all the affinity between his own definition of the art of leadership—"making common men do uncommon things"—with that of Buchan. That factor cannot be ignored in any study of government, of the relations between power and influence. Without it, integrity, intellectual ability and the capacity for sustained hard work can be ineffective—the tools of tyranny as readily as of freedom. Nor without it is experience alone likely to engender that sense of timing and of what is appropriate and possible which lies at the root of wise administration and government by consent. To arrive at a solution of this problem of power and influence, we must at least consider the processes by which such gifts are developed or acquired and also the conditions under which they are most effectively exercised. No reader of Lord Reith's "Into the Wind", for example, could imagine that the author was lacking in personality, or that he underrated the factor which Lord Beveridge discounts. The clue to Lord Reith's frustration is to be sought rather in the conditions in which personality is exercised, and his book might equally suggest an inquiry into the nemesis of power.

The right relations of power and influence turn as much on this question of personality as they do on the relations between knowledge and power. The task of government at any level to-day, from the international to the local level, involves increasingly the wise use of experts. Decisions and policy must be based on accurate knowledge and technical considerations, though not solely on these. If, however, such considerations are ignored, or the facts wilfully disregarded, disaster may well ensue.

The real challenge of the atom bomb or the hydrogen bomb comes into this context; only secondarily is it a moral challenge. Primarily it is a challenge to the hard thinking required to reshape institutions and policies to take full account of facts that do not consort with the form or practices in which ideas or prejudices have been expressed. If the expert is to be used effectively, he must himself give some attention to the expression of his ideas and to the persuasiveness with which he presents his conclusions as to the kind of policy that his expert knowledge suggests.

For this reason we require not merely experts, in spite of our need of more expert knowledge than ever; we also need men and women with personality, with faith and courage. It is curious that Lord Beveridge, who recognizes clearly enough that, behind his theme of power and influence lies this factor of change and the shaping of institutions and society to meet the needs of a new situation in which action and policy must be determined by knowledge and not prejudice, sees a somewhat false dichotomy between the scientist and the administrator or statesman. His view that the scientist is necessarily unpractical and indecisive will certainly be challenged, nor does it follow that those whose whole energies are spent in advocating some practical reform need be unscientific. The latter depends in part on whether the reform they advocate is based on knowledge rather than prejudice or whim, and in

part on the outlook their training has given them. If, indeed, members of Parliament cannot be scientific and impartial, the prospects of democracy are indeed dim.

Lord Beveridge, it is true, insists that to acquire something of the scientific spirit is vital, and one remark he makes in relation to the chairmanship of the Unemployment Insurance Statutory Committee, which he held during 1934–44, is apposite: "In a world of regulations and controls it seems increasingly worth while to give to those subject to control a chance of expressing their views neither to a preoccupied Minister nor to a permanent official, but to a body of just men with time and independence and the right of making their judgments known". He sees, in fact, as the title of his epilogue tells us, that democracy, which has nothing to say about equality, but refers solely to power and the control of power, is a matter of mental climate. What he does not fully recognize is that the real issue is between two different tempers of mind—the spirit and temper of accommodation and the spirit and temper of intransigence; and his view of the way in which such climates of opinion are formed and changed is colourless and mechanical, lacking the vital quality of personality.

That quality is important, moreover, for yet another reason. The extent to which technical factors enter into sound political decisions means that the efficiency and even the possibility of government depend upon the removal of many such decisions from the range of popular choice. Even when the electorate is competent to make a sound choice, security considerations, as, for example, in the development of the hydrogen bomb and other atomic weapons or guided missiles, may make it impossible for the electorate to be given all the information required as a basis for wise decisions. To some extent that applies to its representatives in Parliament, and that is one reason for viewing with concern the growth in power of the political party system and the tendency to restrain Government policy and decisions within limits set by purely party bodies outside Parliament rather than on the corporate feeling of Parliament itself.

What has to be recognized is that any such removal of decisions from the control of Parliament exercising its corporate sense of the public interest is just as real a threat to liberty as the domination of Parliament by a single class or party. The distinguishing feature of the British constitution hitherto has been the practice of government by discussion between representatives who both possessed the confidence of the people and were free from their detailed control. If a new system is to be evolved or substituted in which decisions and policy are determined by technical considerations and expert knowledge, whether scientific or not, the implications must be faced and an attempt made to solve the problems of persuasion and consent. Failure to do so will destroy the spirit of accommodation and lead to intransigence and tyranny just as surely as the attempt to make Parliament the instrument of a single class or section, sterilized against the conception of the public interest.

There is a further point also which Lord Beveridge has missed. Whether power is gained by accident or design and wielded brutally or responsibly, influence can only be won, and it is exercised continually by personal impact: it is dynamic not static, as so many professional associations forget. This point has a vital bearing on the responsible exercise of power and the place of the expert in government, and Sir Ernest Barker's analysis in his "Reflections on Government" goes much deeper than some current discussions on the adaptation of Parliamentary procedure and organization to the needs of to-day.

In the first place, we need to distinguish between the authority of the expert and that of the government itself. The first resides in the knowledge of the expert in the particular field in which he is qualified, and within which he has both the right and the duty to speak. It is an authority based on knowledge, and limited to that particular subject. The second resides in the competency of a person or body of persons to issue compulsory orders in the political field, and depends on the fulfilment of the conditions under which it was given and the cogency of those conditions in changing political circumstances. It depends accordingly to some extent on sound judgment, based on experience, rather than scientific knowledge, as to the continuing validity of the conditions under which the authority was originally given.

While the personal factor comes in at this stage on the political or government side, on that of the scientific expert it comes in at a different level. First, information, however authoritative in regard to even the most important particular field, must necessarily be compared with, and adjusted to, information in regard to other fields. No issue in politics falls within one field of science and one only. It is here, however, that the claim of the scientific expert is commonly misunderstood. It is not a claim as such to a place in the task or authority of government: it is a claim that those responsible for the task of government should be qualified and competent to assess the significance of particular scientific or technical factors, and to evaluate them along with the other factors involved in matters of public policy.

Second, not only is the information supplied by the expert in regard to his field confined on the whole to knowledge at that particular time: in the main it deals with measurable things, with questions of fact. It is quantitative and is not intended to solve problems of action, other than setting limits within which action is possible. The solution of such problems, which is the task of government, depends on more than the measurement of data and the results which such measurements can give. It may involve also the extrapolation of data to assess the probability of change within the time factor involved in political action. It involves at least a process by which the different but immeasurable claims of right and acknowledgments of duty are made sufficiently commensurable for adjustment to one another and are set to give information about themselves and in

so doing to reconcile themselves to one another in a mutually acceptable solution.

Obviously, the scientist can only make his full contribution through those who possess not only an understanding of the way in which science works, but also sufficient knowledge to assess the validity of recommendations coming from within a particular field. Such persons must combine personality with their general or particular scientific knowledge, and they must also have a clear perception of the limits of scientific and technical knowledge and of the way in which the methods of open discussion and voluntary agreement function in a parliamentary democracy.

As Sir Ernest Barker points out, democracy which rests merely on the will of numbers rests merely on force. When, for example, a parliamentary government ceases to take account of public opinion or of parliament as a whole and reflects purely the views and wills of the party in a majority, it verges on the autocracy of a totalitarian regime. It ceases to be a democracy in the sense in which that word has hitherto been employed in Britain. The force which democracy can employ is inadequate merely as force, because democracy must consort with, as it is based upon, the free and full development of personality. It is not the majority, as a majority, that matters, but each human being as such; and the form of government which we have to find to-day is one which so far as possible elicits and enlists the thought, will, and general capacity, not of a majority but of every member. Such a government depends on mutual interchange of ideas, on mutual criticism of the ideas interchanged, and on the common and agreed choice of the idea which emerges triumphant from these processes. In such a government the influence of the scientific expert can be exerted in the way that is required and that consorts with the method of science itself. It will be a government which rests not on force or on numbers or even on knowledge, but on the spiritual quality of the processes by which it operates; and the effectiveness with which it works depends above all on the personality of those to whom the functions and authority of government are entrusted and the persuasiveness with which they can continuously enlist the understanding, goodwill and participation not of a minority—or even of a majority—but of all the governed.

DE BROGLIE ON QUANTUM THEORY

The Revolution in Physics

A Non-Mathematical Survey of Quanta. By Louis de Broglie. Pp. 310. (London: Routledge and Kegan Paul, Ltd., 1954.) 18s. net.

LOUIS DE BROGLIE has a unique place in the history of science as the man who in 1923 propounded the hypothesis of the wave character of material particles and thereby initiated the great movement of thought concerned in the passage from the 'old' to the 'new' quantum theory. His ideas also led directly to vital technical developments represented, in particular, by the invention of the electron microscope. Since then, besides carrying on his own scientific work, he has taken a leading part in scientific education and administration in France. In addition, he has attained eminence as a scientific writer. The present book is a translation by Ralph W. Niemeyer of one of his most notable expository works (with certain additions). Apparently the main text was written in 1936 and revised in 1946, and a few sections added in 1952.

The book may be described as an exposition, following the historical development, of the whole of quantum theory excluding (apart from brief references) the modern quantum theory of fields and modern nuclear theory. The treatment is strictly non-mathematical, but some descriptive indication is given of the mathematical structure of the theory. The work will appeal to several classes of reader. Presumably it is intended primarily for the general scientific reader, other than the mathematician or physicist, who seriously wants to understand the "revolution in physics" that has taken place in the present century. Such a reader will be well rewarded for the attentive study that the author's thorough explanations invite from him. But, since something like classical physics and something like quantum physics must always be necessary, not only for the sake of their appropriate applications, but also on account of the very nature of physical experience, it is essential to understand as well as may be the relation between these two systems; and since a special feature of the book is the statement of this relation as it stands at present, it should also be of much service to the present-day student of physics. Finally, in view of the central part played by the author himself, the book has special significance as a historical record. In this regard, it can be read as an interesting supplement to the recently published second volume of Sir Edmund Whittaker's "History of the Theories of Aether and Electricity", which also supplies the documentation not included in M. de Broglie's account.

Even in describing his own accepted contributions, M. de Broglie avoids the use of the first person singular. He reserves this form of expression for the statement of a few individual speculations and criticisms. These serve to remind us that, great as have been the successes of the theories described, the "revolution in physics" must never be assumed to have resulted in a settled régime.

W. H. McCrea

AN ASSORTMENT OF PROTEINS

The Proteins

Chemistry, Biological Activity, and Methods. Edited by Hans Neurath and Kenneth Bailey. Vol. 2, Part A. Pp. x+661. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 14 dollars.

THE nine articles that make up this third volume of a four-volume work are, for the most part, good; the information contained in them is well selected and the authors generally approach the statements they are reporting in a pleasantly critical manner. It is therefore more than usually important to consider what the advantage is of having all the articles bound together in one volume, for the con-

sequent restriction on their distribution would matter less if it were not so obvious that much valuable time has gone into the writing. Papers appear higgledy-piggledy in scientific journals by tradition; because their classification would probably involve the editors in unnecessary argument; and because separate reprints are generally looked on by librarians as awkward things to handle. Some of the same arguments justify disorder in annual reviews and similar publications; their contents are united by their ephemeralness and little more is needed. The shortest article here runs to only twenty-five pages, which is perhaps too short to justify separate publication, but two of them run to more than a hundred pages and they would have made admirable books along the lines of the "Monographs on Biochemistry" that were such a valuable feature of the first third of this century. Had they come out in this form it is certain that they would have found more purchasers and probable that they would have found more readers.

Markham and Smith give a clear account of the history of research on the nucleic acids, nucleoproteins and viruses; and they point out how often apparently new methods had already been used by the older worker. Their criticisms of recent work are in the main valuable, though sometimes a little facile. The section on bacterial viruses is particularly good because it brings out the nature of the actual observations made; these have often recently been lost sight of in a fog of interpretations.

Work on the oxidizing enzymes has been more thoroughly integrated than any other part of biochemistry. Singer and Kearney classify it under the four main prosthetic groups, copper, pyridine nucleotide, flavine nucleotide and thiamine. They are careful to avoid the generalizations that loom so large in less specialized text-books and emphasize the importance of always mentioning the source of an enzyme in its name. Enzymes from different sources often have widely different properties though catalysing the same action, and the stress laid on this will help to focus attention on the nature of the minimum structure needed to bring about an action.

A straightforward, if pedestrian, article on respiratory proteins is followed by van Heyningen on toxic proteins. This is a well-planned account of an unusual subject; the main criticism of it is that some of the physiological and zoological jargon will not be comprehensible to chemically trained readers. He discusses critically the mode of action of these toxins, the evidence that they are useful to the organisms making them on account of the properties that we investigate, and the dangers underlying the assumption that, because a protein can do something, that is necessarily what it does do *in vivo*. McMeekin, on milk proteins, is less successful in resisting the allure of teleology. His article, and also the two on egg and seed proteins, brings out clearly the manner in which protein preparations, which appear to be homogeneous by two or three different criteria, are often shown to be inhomogeneous by the application of a third or fourth. The general recognition that homogeneity is not a property that can be demonstrated in proteins because it is, strictly speaking, only the absence of a defined type of inhomogeneity, is one of the most satisfactory aspects of research during the past decade.

Steward and Thompson have a completely different conception of the general character of the book from that shared by most of the other contributors. Their article is called proteins and protein metabolism in plants, but it is in fact a comprehensive and uncritical review of the greater part of the broader field of nitrogen metabolism in plants and much of it is only tenuously connected to proteins. If it makes more biochemists aware of the value that a plant's metabolic plasticity has in research, it will be useful.

Finally, Li describes the protein hormones in a straightforward and factual way. In the section on insulin he discusses species differences and the extent to which an activity can be shared by several different structures. It is a pity that this point, so well emphasized by Singer and Kearney, is not stressed for the other hormones too. There is generally no clear statement whether those made by different organisms are supposed to be identical or not.

The editors are to be congratulated on a book nearly free from printing errors, but they seem to have made little attempt to prevent overlapping or to put in cross-references where it does occur. There is, for example, more about the L-amino-acid oxidase of snake venom in the chapter on oxidizing enzymes than in that on toxic proteins, but neither mentions the other. To revert to the argument in the first paragraph of this review, one possible advantage of binding several articles in one volume has therefore been missed. Those who think of buying only one volume out of the four, because their tastes are catered for by the accidental grouping of articles in it, have been partly defeated by the editors. They have reserved the index for the last volume. The adequacy of the index cannot therefore be commented on.

N. W. PIRIE

THE WAY OF SEX

Sex and the Nature of Things

By Dr. N. J. Berrill. Pp. 256. (London: Victor Gollancz, Ltd., 1954.) 13*s.* 6*d.* net.

Reproduction and Sex

By Dr. G. I. M. Swyer. (Survey of Human Biology.) Pp. viii+280. (London: Routledge and Kegan Paul, Ltd., 1954.) 25*s.* net.

THESE two books are complementary and are both excellent expositions. Neither is meant for specialists, so biologists and endocrinologists should avoid them; but those whose subjects lie in other directions will find them enjoyable. Dr. Berrill's reminds one of those pleasant essays which Sir Ray Lankester published in the days of our youth, called "Science from an Easy Chair". However, his were on general biological topics, whereas Dr. Berrill's is really a history of the evolution of sex from the most primitive appearance of it as hermaphroditic reproduction in tunicates to the complication of placentals.

In some ways, Dr. Berrill disagrees with the usually accepted theory. For example, he believes that the giant reptiles, such as the dinosaurs, were exterminated by an increase in the temperature rather than by cold. It was this which caused the evolution of mammals by the shedding of reptilian scales, the development of sweat glands, and the growth of hair as an insulating medium, the production of heat by the muscles and the control of its loss by the nerve supply to the cutaneous blood vessels. He suggests that the first mammals were nocturnal animals because of their dull coloration and lack of colour vision, which contrasts with the birds and reptiles.

However, the book is not primarily concerned with such theories, interesting though they are, but with

the evolution of sex, and he deals at length with the choice of a mate, mating behaviour, sexual dances of birds, and the sexual conduct of reptiles and mammals.

I have noticed only one tiny slip. On p. 128 Dr. Berrill suggests that a man's interest in the female disappears when he has insufficient male hormone; this is not necessarily true—it is, however, a triviality.

Dr. Swyer's book is not concerned with the evolution but with the manifestation of sex in the human. He gives first of all an outline and then goes on to describe reproduction in the male, the function of the adrenal cortex, and the female reproductive cycle. After this he deals with disorders of menstruation and the climacteric, and then with anomalies of sexual development. He describes conception, pregnancy and its special problems, childbirth and the problems associated with it, and breast feeding. He gives a chapter on fertility and infertility. Finally—most unusual in a book of this kind—Dr. Swyer devotes space to the psychological side of sexual behaviour and its development as well as the sexual anomalies and disorders. There are two appendixes: one on the anatomy of the reproductive organs and one on tubal patency.

There are innumerable popular books on the physiology of sex, but what makes Dr. Swyer's different from the usual 'outline' is that it is written by a specialist who is not only an endocrinologist, but also is consultant to the obstetric department of a large London hospital. He is thus able to approach the exposition of his subject with an intimate knowledge of both endocrinology and obstetrics, which the usual 'popularizer' lacks. The masterly way in which he explains the more complicated elements of female endocrinology in such conditions as menstruation, pregnancy and lactation makes his book well worth reading. Medical men who have lost touch with recent developments of sexual endocrinology could use his volume as a useful introduction; but it is so clearly written that it should be comprehensible to any educated person.

Once the subject of sex was regarded as scarcely a topic to be studied by the layman and not quite respectable. We have fortunately passed by such foolishness, and books such as these show that the ordinary man can be properly informed as to how sex was evolved and how it works. He will find the whole subject fascinating. CLIFFORD ALLEN

ASPECTS OF BIOCHEMISTRY

Essentials of Physiological Chemistry

By Prof. Arthur K. Anderson. Fourth edition. Pp. vii+480. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 40*s*. net.

Dynamic Aspects of Biochemistry

By Prof. Ernest Baldwin. Second edition. Pp. xx+544. (Cambridge: At the University Press, 1952.) 30*s*. net.

General Biochemistry

By Prof. Joseph S. Fruton and Prof. Sofia Simmonds. Pp. xii+940. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 80*s*. net.

IT would be difficult to find three such dissimilar books dealing with the same branch of science. In the handling of the subject-matter and in the scope of presentation each book differs sharply from the others, but each has its own distinctive part to play in the biochemical literature.

Prof. Anderson's book is an elementary text of moderate size which first appeared in 1935 and which has now demonstrated its popularity, particularly in the United States, by reaching its fourth edition. It is essentially a book in which the beginner is introduced to biochemistry by the classical sequence of chemical structure of carbohydrates, lipids and proteins, their digestion, their metabolism and the excretion of the final products. The bias is heavily in favour of animal biochemistry, the physiological side is stressed—and rightly so in an introductory text—and the book is thus set to the level of the second-year medical student.

For the reader who has mastered Anderson—or its equivalent—Baldwin is the next logical step in his biochemical education, and the second edition of this remarkable book will be greeted with all the greater interest since the first edition achieved the unusual distinction of becoming a biochemical best seller. In spite of Prof. Baldwin's contention that this book is an elementary text-book, the reviewer cannot agree that it is an introduction to the subject, for the story does not begin at the beginning, and the reader who has not progressed to Baldwin from a more elementary text will soon find himself in difficulties. The book, moreover, does not attempt to cover the whole field of biochemistry, but deals briefly but comprehensively, at what is essentially an intermediate level, with the very body and bones of the subject—enzymology and metabolism, using the latter word in its broadest sense. The loose ends in the first edition have been tidied up and recent developments, including energetics, have been included with the same characteristic clarity and vigour of presentation as made the first edition so widely popular. In spite of the minor weakness due to the inadequate size of the bibliography, Baldwin's "Dynamic Aspects" has by now reached such an established place that no biochemical education is complete without it.

While Baldwin deals with aspects, Fruton and Simmonds cover the whole field, at what might be called a sophisticated level. As befits a text for advanced students, it plunges straight into the proteins before progressing through the enzymes and biological oxidations to a detailed study of intermediate metabolism. To attempt to write a comprehensive advanced treatise on a subject which is advancing and changing with disconcerting speed is a formidable task which few have attempted, but which has in this case been achieved with outstanding distinction. Of the two salient features of the book, one is its characteristic freshness of presentation; the authors have been fettered by none of the classical traditions which tend to stamp a pattern of uniformity on older books of a similar type, but have covered modern biochemistry in the way which seems to them—and to the reviewer—to be logical and systematic. The layouts of formulæ, figures and diagrams are entirely modern. The other characteristic feature is the wealth and breadth of documentation with chapter and verse given for each statement up to a remarkably recent date. Yet this comprehensive treatment of a big subject is compressed into 900 very readable pages. This book deserves to go through many editions—if the authors are prepared to face the formidable task of quinquennial, or even more frequent, revision.

J. N. DAVIDSON

THE ASSOCIATION OF APPLIED BIOLOGISTS (1904–54)

By R. W. MARSH
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ON November 8, 1904, Mr. Walter Collinge, of the University of Birmingham, called a meeting in the rooms of the Linnean Society, London. The seven workers interested in applied biology who attended agreed to the foundation of the Society that is now known as the Association of Applied Biologists. At this first meeting a total of twenty-seven original members was elected: they included Sir Ronald Ross, Sir Arthur Shipley, Prof. A. H. R. Buller, Prof. Maxwell Lefroy, Prof. F. V. Theobald and Mr. Cecil Warburton, now a centenarian and the only remaining survivor of the group of original members.

When the Association was inaugurated, applied biology was the pursuit of a few scattered workers, most of whom had other official duties. The first British appointments specifically for research in applied biology had been made within the previous two years at Rothamsted and Long Ashton. From 1905 until 1909 a major aim of the newly formed Association was to bring to the notice of government and university authorities the existence and potentialities of applied biology. To achieve this aim the Association became a peripatetic body, holding meetings in Birmingham, Liverpool, Cambridge, London, Edinburgh, Oxford, Manchester and Dublin. Among the subjects discussed in these early years were cereal breeding, the American gooseberry mildew, the Isle of Wight disease of bees, the larch sawfly, and the feeding habits of British birds. By 1909 the proselytizing activities of the Association had induced the enrolment of 132 members and had gained widespread recognition of the importance of applied biological research in the national economy.

This recognition was given tangible form in the constitution of the Development Fund by Parliament in 1909 with an allocation of £2,900,000 for aiding and developing agriculture and rural industries. In 1911 the Commissioners appointed to administer the fund adopted a scheme for the establishment of research institutes, the provision of technical advice, the support of research outside the institutes and the establishment of a scholarship scheme for training scientific workers. These provisions made a secure basis for the enlistment of a number of professional applied biologists, which, in its turn, was reflected in the increased activity of the Association.

By 1912–13 it was felt that the Association would function more satisfactorily if its headquarters were in London and if the existing arrangement whereby members published in the privately owned *Journal of Economic Biology* could be terminated. Stimulated particularly by the energy and vision of Prof. Maxwell Lefroy, the Association launched in May 1914 its own journal, the *Annals of Applied Biology*.

In its new role as a publishing society, the Association was almost immediately confronted with problems arising out of the First World War and its aftermath. With much difficulty, the publication of the *Annals* was maintained; but the other activities of the Association virtually ceased during the war period. The years 1918–21 were marked by recurrent financial crises threatening catastrophe, from which the Association was saved only by the resolute efforts of Prof. W. B. Brierley. He restored the stability of the Association and became editor of the *Annals of Applied Biology* in 1921. For the next twenty-five years, Prof. Brierley piloted the *Annals* to its position of unquestioned prestige.

A second period of major expansion in applied biology followed the 1921 repeal of the Corn Production Acts when, as a solatium to the farming industry, £850,000 was allotted to agricultural education and research in the ensuing five years. Within the agricultural research institutes and the advisory services many developments that had been held in abeyance since 1914 were thus facilitated, and the membership of the Association rose to 250 by 1925. During the next decade the expansion of the Department of Scientific and Industrial Research, the grants made by the Empire Marketing Board, and the attention paid to Colonial agricultural development all led to increases in the number of appointments in applied biology, reflected in demands for more meetings of the Association and for increased provision for publication.

In consequence, the activities of the Association from 1922 to the end of the inter-war period showed steady expansion. In addition to the four meetings or symposia held annually in London—where the Imperial College of Science and Technology has generously acted as host to the Association since 1917—one or more provincial and field meetings were arranged each year at centres throughout the British Isles. The *Annals of Applied Biology* was expanded from a volume of 359 pages and 14 plates in 1922 to one of 940 pages and 51 plates in 1937.

During the Second World War the expansion of the Association continued; but Prof. Brierley had to meet the problem of maintaining the publication of the *Annals* in spite of drastically reduced paper supplies and rising costs. He overcame these difficulties so successfully that at the end of the War it could be recorded that the *Annals of Applied Biology*, almost alone among British scientific quarterlies, had maintained the issue of four numbers a year in unbroken succession. During the War, the printing order for each issue remained restricted to seven hundred copies: this figure has now risen to 1,800.

Membership of the Association, now approximately seven hundred, includes on an equal footing research, advisory and teaching workers in government service and in industry, in Britain, the Commonwealth and Empire, and in many other countries throughout the world. The interests of the members, which are reflected in the *Annals of Applied Biology*, include all aspects of plant pathology (in its widest sense), the problems relating to stored products, plant and animal physiology and the application of statistical methods in biology.

Over the past fifty years the ever-increasing diversity of the elements making up applied biology has emphasized the need for bridging and integration

in this field. The correlation of pure science with practice and the maintenance of the links between the interests included in applied biology has been and remains a major contribution made by the Association to the advancement of scientific knowledge.

JUBILEE CONFERENCE ON SEPTEMBER 13–17

THE Golden Jubilee of the Association of Applied Biologists was celebrated by a programme of lectures and symposia held at the Imperial College of Science and Technology, London, during September 13–15, followed by visits to research stations on September 16 and 17. Registered members of the Conference numbered 430, including 62 from twenty-one countries outside the United Kingdom.

At the opening meeting in the Jehangir Hall of the Imperial Institute, the president, Prof. William Brown, read the messages that had been sent to H.M. the Queen, to Prof. W. Brierley, and to Mr. Cecil Warburton, the only surviving original member of the Association. After giving a brief history of the Association, he welcomed the members and visitors. Dr. E. Gram (Denmark) responded on behalf of the visitors from Europe, and Dr. Starr Chester, replying for the North American visitors, conveyed the greetings of the American Phytopathological Society.

The inaugural address was delivered by Sir John Russell on "The Changing Problems of Applied Biology". Sir John recalled the early developments of the subject: the writings of Berkeley, Curtis and Miss Ormerod, the pioneer course in agricultural chemistry given by Prof. Liveing at Cambridge in 1891, and the establishment of Wye College under A. D. Hall in 1894.

In tracing the subsequent advances in applied biology, he attached major importance to the effects of the growth of technological organic chemistry that started during the First World War. Among the repercussions of this development were the far-reaching advances in all aspects of the work on crop protection products and growth-regulating substances. Another major impetus was given by the work of R. A. Fisher on the application of statistics to applied biology. The study of virus diseases of plants formed an outstanding example of advances in a field that was completely unexplored fifty years ago.

Sir John stressed the danger that specialists in applied biology may easily lose touch with each other, a danger that the work of the Association has done much to avert.

The guest lecturer on the evening of September 13 was Prof. E. C. Stakman, of the University of Minnesota. Taking as his subject "Progress and Problems in Plant Pathology", he emphasized the gravity of plant disease losses in an underfed world and listed the major contributions made by plant pathologists in reducing these losses.

Dealing with the control of black rust of wheat, Prof. Stakman showed that the eradication of 260 million barberry bushes in the United States between 1918 and 1941 had restricted the number of important races of the rust in North America to four. Wheat varieties resistant to these strains were bred and provided a satisfactory solution of the rust problem from 1938 until 1949, when the new race 15*b* attacked the hitherto rust-resistant varieties.

Prof. Stakman dealt with the possible means of origin of such new races from uredospore crosses. In maize smut, which can be grown in culture, mutant forms can be induced by using uranium nitrate, and these show a range of pathogenicity and of resistance to fungicides.

Prof. V. B. Wigglesworth (Cambridge) gave the evening lecture on September 14 on "The Contribution of Fundamental Research to Applied Biology". He attributed most practical advances to empirical attack, the function of fundamental research being to contribute fresh outlooks stimulating new methods of approach. A major difficulty in supporting basic research lay in the impossibility of determining which ideas would lead on to fruitful results. Karl Pearson, for example, writing in 1892, had selected the newly-described Hertzian waves—the waves of radio—as one discovery that could never be of any practical value.

The increasing cost of research work has made universities more and more dependent on the funds provided by the research councils, which are naturally aiming at practical objectives. There is therefore a danger of the neglect of fundamental research in biology, with the consequent loss of the source of new ideas. Prof. Wigglesworth commended the suggestion of Prof. Paul Weiss in the United States, that organizations supporting applied research should devote a fraction of their budgets to the cost of completely unfettered fundamental studies.

The closing lecture was delivered by Dr. K. W. Neatby, director of the Canadian Department of Agriculture Science Service, on "The Application of Biological Research to Canadian Agriculture and Forestry". In a survey of the history and organization of applied biology in Canada, he stated that the preponderating contributions were made by workers in government service—applied biology is still a relatively neglected subject in Canadian universities.

After dealing with problems of insect balance in orchards and climatological factors in tree diseases, Dr. Neatby described a method used at Ottawa for accelerated wheat breeding, enabling three generations a year to be raised in controlled-temperature chambers. The baking quality of small amounts of the newly-bred wheats can now be rapidly assessed by measuring the expansion of balls of fermenting dough in weak salt solution, and milling properties are to be tested in a micro-mill which is being constructed to produce flour from less than an ounce of wheat.

The remaining papers presented at the Conference were grouped into ten symposia. The topic of "International Co-operation in the Field of Crop Protection" was introduced by Mr. W. C. Moore (Plant Pathology Laboratory, Harpenden). As an example of progress already made, he referred to the International Plant Protection Convention, sponsored by the Food and Agriculture Organization in 1951 and now accepted by forty countries undertaking to collect and exchange phytopathological information, to carry out plant health inspections and to issue export certificates conforming to an agreed standard. The European Plant Protection Organization has since 1950 studied and recommended means of restricting the spread of pests and has organized the campaigns against the Colorado beetle.

These campaigns were described by Dr. V. E. Wilkins (director-general of the European Plant Protection Organization). He recounted the early devices for arousing public interest and showed the benefit derived by Britain from the reduction of infestation in the Cotentin peninsula and in the Pas de Calais. Eradication of the musk rat in Holland is also being attempted by the Organization. The fall webworm (*Hyphantria cunea*) spread in 1951 from Hungary to Yugoslavia, where it caused defoliation of fruit and forest trees. By 1953 the control campaign had averted the threatened spread of this pest to the rest of Europe.

Dr. E. Gram (State Plant Pathology Institute, Denmark) surveyed the problems of preventing the introduction of pests and diseases on plants sent from one country to another. He considered that air transport of plants and the world trade in grain need more supervision by plant health authorities. Dr. Gram advocated an extension of pest and disease surveys, of field inspection services and of fumigation before shipping. Improvements in these matters should make it possible to simplify some of the present quarantine procedures.

In the symposium on "Insect Pests of Stored Products", Mr. F. R. Cann, of the Infestation Control Division, Ministry of Agriculture and Fisheries, spoke on the biological aspects and economic problems of the entomology of stored products in temperate countries. He divided these pests into three groups—those endemic in Britain, pests introduced from other temperate countries, and those arriving from the tropics. The 'temperate group' increases very rapidly in the warmer months and their attacks can be reduced by cool storage (40–50° F.). Some introduced tropical species, such as Pharaoh's ant, can continue to breed in bakeries and other heated buildings.

Dr. E. A. Parkin (Pest Infestation Laboratory, Department of Scientific and Industrial Research, Slough) reviewed progress in the control of insects infesting stored foodstuffs. After stressing the importance of cleanliness and order in the food-store, he surveyed developments in fumigation by ethylene oxide, methyl bromide and chlorinated hydrocarbons; he then dealt with the use of contact insecticides—pyrethrum, DDT, 'Gammexane' and inert mineral dusts. Concerning future developments, Dr. Parkin considered that the biggest gain would come from focusing attention on the biology and behaviour of a particular insect in specific products.

Dr. D. W. Hall, from the same Laboratory, dealt with problems of food storage in tropical countries. Here, major difficulties arise from the unsuitability of the traditional types of storage and the lack of trained staff. After only five years work, considerable advances have been made in Africa in developing methods of storing grain in sealed pits and in silos. Fumigation under gas-proof sheets has been successfully applied to groundnuts in Nigeria since 1949 and is now being adopted for maize in Tanganyika and Nyasaland. Efficient storage techniques in the tropics are essential as a defence against malnutrition and famine.

A symposium on "Plant Viruses and Virus Diseases" was held on the morning of September 14. Dr. Kenneth Smith (Agricultural Research Council Plant Virus Research Unit, Cambridge), surveying past and present trends in plant virus research, said that two outstanding advances have been the recognition of latent infections and the proof of virus multiplication within the insect vector. Since 1935 the focus has been on the virus itself, facilitated by the electron microscope. Progress is now being made in determining the part played by nucleic acid in virus multiplication.

Prof. E. van Slogteren (Laboratory for Bulb Research, Netherlands) spoke on serological diagnosis of plant virus diseases. He described the development of the methods used in Holland and gave details of the organization and techniques used for the large-scale examination of potatoes to test their freedom from virus infection.

Dr. F. O. Holmes (Rockefeller Institute for Medical Research, New York), in a paper on additive resistance to virus diseases in plants, took as his principal example the susceptibility of *Nicotiana* spp. to tobacco mosaic. Plants of *N. glutinosa* can be readily infected, but permit little spread of virus in the tissues and show very low capacity for virus liberation. Crossing *N. glutinosa* with *N. tabacum* gives hypersensitive plants which do not act as sources of infection and so provide a means of controlling mosaic in the field.

Mr. F. C. Bawden (Rothamsted Experimental Station), speaking on the spread and control of plant virus diseases, made the point that the nearest relatives to viruses are normal nuclear proteins. Genetic crosses may conceivably give rise to completely new viruses. In the past fifty years, control measures based on inspection and certification schemes have gone far to free the British potato crop from leaf roll and virus Y. Insecticides have not prevented insect transmission of viruses: what is needed is a 100 per cent effective repellant. Infection by the contact-spread mosaic of tomato can be inhibited by a protectant spray of skim milk. Isolation cannot be considered a trustworthy means of maintaining virus-free stocks of plants until the host range of the relevant viruses is established.

The symposium on "Plant Growth-regulating Substances" opened with a paper by Prof. R. L. Wain (Wye College, University of London) on a new approach to selective weed control. He gave an account of his fundamental investigations on the breakdown of the side-chain of members of homologous series of certain ω-phenoxyalkylcarboxylic acids within plant tissues. He presented chemical, biological and chromatographic evidence showing that β-oxidizing enzyme systems capable of degrading specific acids of this type may be present in the tissues of certain plant species and not in others. From this finding, Prof. Wain developed his new approach to selective weed control based upon enzyme make-up. The results of preliminary experiments along these lines are so promising that it now seems certain that various γ-phenoxybutyric acids, for example, have a part to play in controlling weeds in such crops as celery, parsnip, carrot, clover, lucerne and peas, and have little or no phytotoxic effect.

Dr. W. G. Templeman (Jealott's Hill Research Station), speaking on the uses of plant-growth substances, gave an account of their employment in rooting of cuttings, inhibition of bud-growth, production of parthenocarpic fruits and prevention of fruit-drop. The date of pineapple harvest in Hawaii can now be accurately regulated by a single application of α-naphthylacetic acid to induce flower primordia formation. Dr. Templeman recorded the detailed sequence of the British and the

American discoveries of growth regulators as selective herbicides.

The activity of plant-growth regulators was discussed by Prof. H. Burström (University of Lund). He said that the effects of certain *iso*butyric acids that have been termed anti-auxins might be expected to be the reverse of those of the auxins (β-indoleacetic acid, etc.). However, in certain circumstances these anti-auxins behave like the auxins in increasing cell multiplication, enhancing cell-wall extensibility and, when in high concentrations, inhibiting root-growth. He suggested that the auxins, the herbicides and the anti-auxins all form one group characterized by the ability, present to a varying degree, to induce specific formative effects.

Prof. L. J. Audus and Mr. K. V. Symonds (Bedford College, University of London) reported further studies on the bacterial breakdown of hormone weed-killers in soils. Using a perfusion technique to examine the persistence of 2 : 4-D, they showed that the herbicidal effect of the soil perfusate remains unchanged for twenty days but then disappears completely in 48 hr. An organism of the *Bacterium globiforme* group was isolated and was shown to utilize 2 : 4-D as a carbon source. They suggest that the bacteria during their early period of proliferation gradually convert 2 : 4-D to another phytotoxic intermediate. Meanwhile, the bacteria are producing an adaptive enzyme system which, at the end of the twenty-day lag phase, destroys the intermediate. This hypothesis is supported by chromatographic studies.

The first paper in the symposium entitled "Problems in Applied Zoology" was by Dr. J. Carmichael (Boarded Barns Farm, Ongar, Essex) on insects of veterinary importance and Colonial development. He pointed out that the tsetse fly, because it transmits trypanosomiasis, denies to man and his domestic animals the use of vast areas of potential cattle-country in Africa. Attempts to eradicate tsetse are being made by selective forest clearing and by aircraft application of DDT and BHC, with and without the use of defoliants. The other important group of insects concerned with the development of the livestock industry in the Colonies are ticks, which transmit many serious diseases. Ticks are being controlled by dips containing arsenic, DDT, BHC and toxaphene.

Dr. T. H. C. Taylor (Anti-locust Research Centre) discussed the biological control of insect pests. He emphasized that the control of pests by introduced natural enemies is, at its best, superior to all other methods in cheapness, efficacy and permanence. However, there have been relatively few examples of completely satisfactory control by this method. It has been most successful on tropical islands : it cannot, as a rule, be combined with chemical methods. There is still an urgent need for studies of the biological and other factors causing fluctuations in insect numbers. Our aim should be to acquire the knowledge needed to ensure that the conditions we create for crop production do not unduly favour potentially harmful species.

The address by Prof. J. B. Cragg (University of Durham) on the natural history of sheep blowflies in Britain gave an account of the species responsible for sheep myiasis and discussed their movements and breeding sites. In describing oviposition studies, Prof. Cragg showed that attractants in traps gave different results from those on sheep, and he postulated that sheep wool provides an olfactory stimulus specific for female *Lucilia sericata*. He reviewed the experimental data on the micro-climate of egg masses in fleece.

"Soil-borne Pests and Diseases" were discussed in a parallel session. Dr. S. D. Garrett (University of Cambridge), surveying a century of investigation of root diseases, recorded that the phase of etiology, starting a hundred years ago, continued into the early years of the twentieth century, to be followed by a phase of environmental studies. With the discovery, around 1930, that other micro-organisms are the paramount factor in the environment of a root-disease fungus, the phase of microbial ecology began. Complete epidemiological analysis of a root disease is essential before biological control can be established on a scientific basis, or integrated with other measures of good crop husbandry.

Dr. J. Rishbeth (University of Cambridge) dealt with root diseases in plantations with special reference to tropical crops. He showed that field observations and experimental work with root-infecting fungi have indicated some possible methods of control. Thus, with tea, ring-barking forest trees before felling considerably restricts subsequent damage from *Armillaria mellea* and, with conifers, painting or creosoting stumps directly after felling reduces infection by air-borne spores of *Fomes annosus*. Stump extraction has also proved valuable, especially with rubber.

Dr. J. Doeksen (Netherlands Central Institute of Agricultural Research) spoke on the development in research and control of some important soil-borne pests. He stressed the importance of maintaining the balance of beneficial and noxious insects in the soil and issued a caution against the indiscriminate use of soil insecticides.

The opening contribution to the symposium on "Education and Extension Services in Applied Biology" was by Dr. L. M. J. Kramer (City of London School). Speaking on the subject of the applied biologist, the child and society, he claimed that present school biology contains insufficient ecology to show how applied biology is essential to maintain the contemporary scale of human society. Investigation of examinations, social phenomena and the education of Civil servants and members of Parliament indicates the potentialities of biology. There are sufficient senior pupils to provide the applied biologists needed, and evidence suggests how they may be guided.

Prof. W. Brown (University of London) pointed out that as biological research becomes more and more physiological the need for training in physics and chemistry increases. Pre-university training in biology is desirable to make good citizens, but may be detrimental to the prospective biology specialist if it is given at the expense of chemistry and physics. At the university the student in pure science (botany or zoology) should be given as good an introduction as possible to the applied branches : this can be achieved by vacation work in farming or horticulture. Such experience is particularly valuable for those who would be taking up administrative or advisory work.

Sir William Slater (secretary, Agricultural Research Council) spoke on biological education for agricultural research. This service needs men trained for research in the laboratory and in the field, and the requirements for both are equally high. Agreeing that the undergraduate being trained for biological

research must have physics and chemistry as well as biology, Sir William made a plea for a limitation of the mass of facts now to be memorized in university courses—a burden that is smothering enthusiasm and imagination. A mastery of principles and methods should be the aim of undergraduate training, leaving the detailed study of a specialized branch of biology to the early postgraduate years.

Mr. R. Rae, director of the National Agricultural Advisory Service, described the work of that Service. He summarized its organization, gave details of its work and noted some of its principal achievements since its inauguration in 1945.

The symposium on "Crop Protection" began with an address by Dr. Hubert Martin (Science Service Laboratory, London, Ontario). In considering some basic problems in the application of chemistry to crop protection, Dr. Martin pointed out that the subject of insecticides has extended beyond the confines of chemistry and entomology. It now delves deeply into enzymology and electrophysiology. The possibility that toxicants may act on nuclear proteins, thus inducing phenomena comparable to mutations, is of great significance when highly potent crop-protection chemicals are added to the soil.

A paper by Dr. A. E. Dimond and Dr. J. G. Horsfall (Connecticut Agricultural Experiment Station) was entitled "Fifty Years of Fungicides". In the relatively dry summer climate of the United States, the replacement between 1944 and 1950 of Bordeaux mixture by thiocarbamates as potato sprays was followed by a doubling of yield. Future achievements would probably be in internal therapy of plant diseases. The *Fusarium* wilt of carnations is already being controlled commercially in Connecticut by internal therapeutants.

Dr. W. E. Ripper (Pest Control, Ltd.) discussed the development of methods of application for crop protection chemicals. He showed the importance of size of spray droplet and reviewed the existing types of spray machinery and techniques, with special reference to helicopter and aeroplane applications.

Dr. E. Holmes (Technical Department, Plant Protection Ltd.) spoke on the contribution of commerce to plant protection. After giving examples of fundamental chemical and biological studies made by industry and their contributions of new insecticides, fungicides and weed-killers, he dealt with the cost of developing new products and the economic benefits that their use had conferred on agriculture.

"The Forecasting and Assessment of Plant Diseases" formed the subject of the symposium that was opened by Dr. K. Starr Chester (Battelle Memorial Institute, Ohio), who spoke on scientific and economic aspects of the appraisal of losses due to plant disease. He stressed the advantages that would accrue to the agencies and industries serving agriculture if accurate information on losses due to disease were available. He noted the progress made by North America and Western Europe in plant disease surveys and assessments, and described international co-operation in this field now being developed through the Commission on Plant Disease Losses and the World Reporting Service of the Food and Agriculture Organization.

Mr. E. C. Large (Plant Pathology Laboratory, Harpenden), dealing with methods of measurement and forecasting of plant disease in Great Britain, outlined the methods devised for assessing losses due to tulip fire, apple scab, choke of cocksfoot, common scab of potatoes and potato blight. For the last-named he demonstrated the accuracy of present forecasting methods and showed maps giving accurate measures of regional losses from potato blight in England in a dry season (1952) and in the wet season of 1953.

Dr. D. Hille Ris Lambers (Bladluisondezoek, T.N.O., Netherlands) spoke on potato aphids and virus diseases in the Netherlands. Seed potatoes in Holland must be lifted by a date that is determined each year by the onset of aphis-spread virus infection. The relation of this date to the yearly fluctuations in aphid population was discussed.

A session on "Plant Nematodes" opened with a paper by Dr. B. G. Peters (Rothamsted Experimental Station) entitled "Nematology in Retrospect and Prospect". He showed that the first small nematodes to be described, free-living in the seventeenth century and plant-parasitic in the eighteenth, are identifiable only from their peculiar habitats; taxonomy came relatively late because adequate optical equipment was a prerequisite. In the study of the free-living and plant-parasitic nematodes, the development of two aspects of taxonomy, figure drawing and mensuration, can be traced in the work of five founders, all of whom were living in 1904: Bastian, Bütschli, de Man, Cobb and Goodey. Possible future developments in the identification of species and strains, the investigation of host–parasite relationships and the training of nematologists were briefly discussed.

Mr. F. G. W. Jones (School of Agriculture, Cambridge) spoke on quantitative methods in nematology. He reviewed the techniques of extracting and counting soil nematodes and discussed methods of assessing the errors in laboratory sampling. In field sampling, there is still little information on which to select the best depth, size and number of samples. Mr. Jones described recent developments in assaying the egg contents of eelworm cysts and egg viability. He emphasized the need for further study of nematological techniques to find how time and effort could be saved without loss of accuracy.

The third paper in this symposium was contributed by Dr. P. Bovien (State Plant Pathology Institute, Denmark), who discussed host specificity and resistance to plant nematodes. He considered that there are degrees of resistance, often specific to host variety. The situation is further complicated by the existence of biological races of eelworms, each with a different host-range. Eventually, non-morphological characters may have to be accepted as defining eelworm species.

A conversazione was held on the evening of September 14 in the Main Chemistry Laboratories of the Imperial College. The ninety-five exhibits were grouped into the following twelve sections: growth and soil investigations, plant breeding and crop improvement, methods in applied biology and taxonomy, medical and veterinary zoology, agricultural zoology, forest entomology and ecology, pests of stored products and of timber, horticultural and agricultural entomology, plant pathology and virology, helminthology, chemical methods of plant and animal protection, and apparatus. The attendance at the conversazione, which was not restricted to members of the Conference, exceeded five hundred.

LOW-TEMPERATURE PHYSICS

EACH year at the meeting of the British Association, the increasing specialization of science is deplored and the perennial half-truth that knowledge advances only at the border of subjects is proclaimed. It was refreshing, therefore, that a whole day at the recent meeting at Oxford could be devoted to low-temperature physics, a specialized subject and one of which the frontiers have steadily retreated from their original position on the edge of chemistry.

It was appropriate that this should happen in Oxford, one of the great centres of low-temperature research, and that the four speakers should be drawn from the Clarendon Laboratory.

The first address, by Sir Francis Simon, surveyed the whole of current low-temperature research and explained why the properties of matter at very low temperatures are of such peculiar interest.

As the temperature of a material system is reduced, its state becomes progressively more ordered; thermodynamically, this is described as a decrease in entropy. Order can be increased and entropy decreased not only by a change in temperature but also by other external influences. The simplest case of this is the isothermal compression of a gas. This change of entropy by mechanical or other non-thermal means is the basis of every method of obtaining lower temperatures; and in general, if a substance possesses entropy which can be lowered by compression, magnetization or any other method, then it can be used as the working substance of a cooling process.

Classical thermodynamics, however, was faced with a dilemma, for the law of equipartition of energy predicted that the specific heats of all substances should be finite at absolute zero. Thus their entropies would be undetermined to the extent of an arbitrary infinite quantity, and the concept of an absolute zero lost much of its usefulness. This dilemma was only resolved by the advent of the quantum theory, which predicted that all specific heats would tend rapidly to zero at low enough temperatures as exemplified by Debye's famous T^3 law.

Sir Francis then stressed the fundamental role of the third law of thermodynamics and its corollary the principle of the unattainability of absolute zero in low-temperature research, remarking in passing that the existence of substances with frozen-in entropy does not constitute a true exception since these are not in equilibrium states.

Sir Francis traced the progressive stages by which entropy is removed as a substance is cooled. First the gas liquefies, then the liquid solidifies. The entropy of the solid will be largely due to lattice vibrations, although in certain substances free rotation of the molecules in the crystal may contribute. In non-magnetic substances the entropy due to all these causes will be almost completely removed at 1° K. In certain magnetic substances, however, the entropy associated with the disordered orientations of the elementary magnetic moments will persist to very much lower temperatures of the order of a few thousandths of a degree. Since this entropy can be influenced isothermally by a magnetic field, this can be made the basis of a method of cooling.

This method of isothermal magnetization and adiabatic demagnetization, first employed by Giauque in 1933, has now been successfully used in a great many laboratories. The lowest temperature attainable by this method is determined by the strength of the interactions between the atomic magnetic moments which are responsible for the ordering of the magnetic system at the lowest temperatures. By a choice of suitable substances in which this interaction is weak, temperatures of the order of 0·001° K. have been reached both at Leyden and Oxford.

Apart from the entropy associated with the atomic moments in paramagnetic substances, there is also the entropy associated with the nuclear magnetic moments. Since the magnitude of these moments is some thousand times smaller, their interactions are very much weaker and it is to be expected that the nuclear entropy will persist to very much lower temperatures—of the order of one-millionth of a degree. In order to make use of nuclear magnetic moments in a cooling process, it is necessary to be able to influence their entropy by the application of a magnetic field. Very large fields of the order of 100 kilogauss applied at very low temperatures of the order of 0·01° K. will be needed. The technical problems this poses have not as yet been surmounted.

Sir Francis Simon concluded by showing how these experiments throw new light on the concept of temperature itself. The naïve association of temperature with kinetic energy clearly becomes untenable when, for example, we consider a 1-mm. cube of diamond at 0·01° K. which contains on the average only one quantum of thermal energy. The concept of temperature is, in fact, inextricably linked with those of order and entropy. A substance which has lost all its entropy is effectively at absolute zero. The temperatures reached by adiabatic demagnetization are perhaps unique in the whole universe. In interstellar space, matter exists at low temperatures but also at very low densities, so that its entropy is large. In stars, on the other hand, while the density is high so is the temperature, and the entropy is again large. It is only in the laboratory that condensed matter at very low temperatures is found.

Sir Francis Simon's introduction was followed by Dr. K. Mendelssohn, who dealt in a picturesque and vivid way with the properties of superconductors and liquid helium, which he tentatively described as a new state of aggregation.

Since the discovery by Kamerlingh Onnes that the electrical resistance of pure mercury vanishes at temperatures below 4° K., a great many other elements, mainly those in Groups IV*a* and V*a* and II*b*, III*b* and IV*b* of the Periodic Table, have been shown to be superconducting. The resistance has been found to be not only small but, in fact, effectively zero, as evidenced by the possibility of obtaining persisting currents in rings of superconductors which showed no diminution in their intensity after periods as long as a week. An empirical law relating the occurrence of superconductivity to the atomic volume of the element has been traced, and this has led to the production of superconducting alloys between two non-superconducting elements, one having too large, the other too small, an atomic volume. These alloys are, in many ways, analogous to the ferromagnetic Heusler alloys.

No completely satisfactory theory of superconductivity exists, although the phenomenological theory, mainly due to the late F. London, has done much to clarify the experimental facts. Superconductivity is a function of the metallic free electrons, and the existence of a specific heat anomaly at the superconductive transition temperature indicates that the entropy of, at any rate, part of the

free electrons is considerably reduced in the superconductive state. They may, therefore, be considered to exist in an ordered state the nature of which is unlike anything we would normally consider to be ordered since they are still free to take part in electrical conduction. Superconductivity has as yet found no practical application, although extremely sensitive bolometers have been made using superconductive elements. A photograph of Prof. D. H. Andrews, of Johns Hopkins University, taken by his own infra-red radiation using a superconductive bolometer as the sensitive element, was shown; its relation to a conventional photograph was as that of a Paul Klee to a Vermeer.

Liquid helium also exhibits behaviour in many ways analogous to superconductivity. At 2·2° there is a discontinuity in the specific heat, the coefficient of thermal expansion and the thermal conductivity. The latter is most strikingly shown when helium is cooled by evaporation. As the temperature is reduced below 2·2°, all bubbling ceases and the liquid becomes perfectly still. This is because the thermal conductivity increases more than a millionfold at the transition temperature. The viscosity of liquid helium measured with an oscillating disk shows no marked discontinuity; yet if an attempt is made to measure the viscosity by studying flow through a fine capillary, it is found that the flow is independent of the pressure head and the apparent viscosity is less than that of any gas, let alone liquid. These phenomena by no means exhaust the peculiarities of liquid helium, and Dr. Mendelssohn went on to describe and illustrate the fountain effect, the mechanocaloric effect and the existence of film-flow, which he likened to the emission of α-particles from nuclei.

In all these ways helium exhibits a similarity to superconductors, for in both cases the underlying phenomenon is transport without friction. Moreover, there is a striking resemblance between the entropy – temperature curves for both classes of substance. This suggests that in both cases the transition from the normal to the superfluid state is associated with the same type of increase of order. Since helium below the λ-point is a liquid, this cannot be spatial order but may rather be pictured as order in momentum-space. This, although not a particularly simple idea, might be visualized by considering the order introduced into traffic moving along a road by the introduction of a speed limit: in the absence of the limit the relative positions of vehicles change with time; after the introduction of the limit, they all move with the maximum permissible velocity, and although the scenery past which they move changes, their relative positions remain the same.

At present there is no complete theory of liquid helium, although the fact that the odd isotope helium-3 does not show superfluidity indicates that part of the explanation of the superfluid behaviour of liquid helium-4 must be that it obeys Bose–Einstein statistics.

Dr. Mendelssohn concluded his address by some remarks of a more speculative nature. Perhaps the cold stars might be regions in which matter exists in the superfluid state, and since we have in superfluidity a new state of matter, may there not be yet another state of matter appropriate to living organisms?

The concluding part of the morning's proceedings was opened by Dr. A. H. Cooke, who described how paramagnetic resonance and relaxation measurements contribute information of great value to low-temperature research.

Prior to the Second World War, most of our knowledge of paramagnetism came from the measurement of the static magnetic susceptibility. The susceptibility is, however, only an average effect due to all the paramagnetic constituents of the substance. Since in even the simplest substances containing only one paramagnetic element the different atoms are often subjected to different internal fields, resulting in a difference in their contributions to the susceptibility, the interpretation of susceptibility measurements in terms of the magnetic properties of individual atoms was an undertaking of considerable difficulty. The method of paramagnetic resonance, on the other hand, studies the properties of each group of atoms separately and makes it possible to give an unambiguous theoretical interpretation of the paramagnetism.

The principle of the method was illustrated using a small gyroscope. When a magnetic field is applied to a magnetic ion, it precesses about the direction of the magnetic field at a frequency which depends on the strength of the field and the ratio of the magnetic and angular momenta of the ion. If an oscillatory magnetic field is applied at right angles to the steady field, the ion will make transitions, from one orientation to another, which absorb energy from the oscillatory field. This absorption can be detected, and thus a measurement of the field and frequency at which absorption occurs allows the determination of the ratio of magnetic to angular momentum. Since the latter is usually known from other evidence and is in any event an integral multiple of $\frac{1}{2}h$, the measurement determines the magnetic moment.

In the demonstration the gyroscope represented the paramagnetic ion, and the magnetic field was applied by means of a length of elastic. When an oscillatory elastic field was applied at right angles, most convincing transitions from one orientation of the gyroscope to another were produced.

Knowing the magnetic moments of the paramagnetic ions in a substance makes it possible to predict many of its magnetic and thermal properties. Paramagnetic resonance experiments, however, give information only indirectly about the strength of the interaction between the magnetic ions, and it is these interactions which determine the behaviour of the substance at the lowest temperatures.

Due to these interactions, there is a contribution C_M to the specific heat which is proportional to $1/T^2$ and is therefore negligible except at low temperatures, where it rapidly assumes a dominant role. For many substances C_M is of the same order as the lattice specific heat at temperatures of a few degrees. Paramagnetic relaxation experiments enable us to determine this magnetic specific heat independently of other contributions to the specific heat.

When a system of spins is magnetized, heat of magnetization is generated, and this has to be lost by the spin system to its surroundings, that is, the crystal lattice. At high temperatures the heat of magnetization is small and the contact between the spin system and the lattice is good, so that this is a very rapid process. At temperatures below 20° K., however, this transfer may take an appreciable time; thus after the field is put on, it may take a fraction of a second for the spin system to lose its heat of magnetization and attain its equilibrium magnetization. Therefore, if the susceptibility is measured using a rapidly oscillating magnetic field, the quantity

observed will be the adiabatic susceptibility of the spin system. A measurement with a static or slowly varying field will yield the isothermal susceptibility. From these two quantities a simple thermodynamic relation leads directly to the magnetic specific heat.

Thus the method of paramagnetic relaxation complements the resonance experiments. Since the magnetic specific heat is a measure of the strength of the interaction between the magnetic ions, and this determines the lowest temperature available in adiabatic demagnetization, relaxation measurements give a useful guide to the choice of substances for demagnetization. For example, iron ammonium alum, with $CT^2/R = 0{\cdot}014$, needs at 1° K. the application of 30 kilogauss to reduce its temperature to 0·01° K., whereas cerium magnesium nitrate, with $CT^2/R = 7{\cdot}5 \times 10^{-6}$, reaches 0·003° K. from a field of 15 kilogauss.

The final paper was given by Dr. N. Kurti and dealt with the low-temperature aspects of nuclear orientation.

The object of this address was the description of methods that have been, or could be, used for orienting atomic nuclei in solids. Normally the elementary nuclear magnets point at random in all directions. Under favourable conditions and at very low temperatures, it is possible to establish preferential orientations with respect either to an external magnetic field or to a crystal axis.

Nuclear orientation was originally conceived as a possible method of producing temperatures of the order of one-hundred-thousandth or one-millionth of a degree absolute. The lowest temperature that can be obtained by means of the adiabatic demagnetization of paramagnetic substances (in which the electron spins are the elementary magnets) is of the order of a few thousandths of a degree. This lowest temperature is determined by the magnitude of the interaction forces between the electronic elementary magnets. With nuclei, which have a thousand times smaller magnetic moments, one could expect to reach much lower temperatures because the interaction forces are smaller. In order to carry out such a nuclear demagnetization experiment, the nuclear paramagnetic substance (say, a metal the nuclei of which possess magnetic moments) has first to be magnetized in a field of between 50 and 100 kilogauss at 0·01° K. This presents great difficulties, and no successful nuclear magnetic cooling has been carried out as yet.

At 0·01° K. and in a field of 100 kilogauss, the nuclei would be directed preferentially along the magnetic field. Such oriented nuclear systems can be of great use to nuclear physics. If we have a radioactive substance which emits γ-rays, then, even if the intensity of emission from one individual nucleus is anisotropic, the total radiation emitted from a piece of material will be isotropic in ordinary circumstances because of the random distribution of the nuclear axes. The behaviour of an assembly of oriented nuclei, however, would approximate more and more to that of an individual nucleus. Details of the importance of such experiments were given in Dr. Grace's paper later in the session.

If one wants to produce oriented nuclei for radioactive experiments, some experimentally simpler methods are also available. Instead of using an external magnetic field of 100,000 gauss, one can make use, in suitable cases, of the strong magnetic fields (of the order of half a million gauss) which the electron spin produces at the nucleus in paramagnetic ions. In such cases the nuclear spin sets itself parallel to this local magnetic field if the temperature is low enough (a few hundredths of a degree absolute). If, moreover, the electron spins which are responsible for these local fields are oriented parallel throughout the specimen, a high degree of nuclear orientation will result. The ordering of the electron spins is brought about either by the action of the electric field of the crystal lattice or by a relatively modest external magnetic field of the order of 1 kilogauss.

The former method was used in the first conclusive demonstration of nuclear orientation in an experiment carried out by Drs. Daniels, Grace and F. N. H. Robinson in September 1951 at the Clarendon Laboratory in Oxford. The anisotropy of the γ-rays emitted by radioactive cobalt-60 which was incorporated in a paramagnetic crystal and cooled to one-hundredth of a degree was clearly shown. Since then many more experiments have been carried out with both methods in Oxford and elsewhere, and in one of the Oxford experiments a degree of orientation of nuclei of more than 90 per cent was attained.

Although at present most of these experiments yield results of main interest to nuclear physicists, the situation will undoubtedly change when nuclear magnetic cooling experiments get under way and, possibly, temperatures of 10^{-5} or 10^{-6} degrees will be reached. It has been suggested, for example, that at these temperatures one might observe 'nuclear ferromagnetism'.

Dr. Kurti concluded by asking whether it is wise and indeed justified to classify these results according to whether they belong to nuclear physics or to low-temperature physics. It is more important, he said, to realize that they are the outcome of a combination of two fundamentally different and distant branches of physics.

F. N. H. Robinson

OBITUARIES

Prof. F. Wood Jones, F.R.S.

With the death of Dr. Frederic Wood Jones at the age of seventy-five on September 29, there passed an anatomist who was well known not only for his numerous contributions to human and comparative anatomy and anthropology, but also for his unusual versatility (his interests extended far beyond the confines of pure morphology) and his vigorous expositions of Lamarckian and teleological conceptions.

Wood Jones was born in London on January 23, 1879, studied medicine at the London Hospital, and graduated in 1903. During 1905–7 he was stationed on one of the Cocos-Keeling Islands as a medical officer of the Eastern Telegraph Co., and it was here that his scientific career may be said to have derived its initial inspiration. For, as he relates, his medical duties were so nominal as to allow him to spend much of his time exploring coral reefs and making observations on the local fauna. In 1910 he published a book on "Coral and Atolls" in which he ventured an original interpretation of atoll development, an interpretation which, even if it did not gain general acceptance, aroused considerable interest because of its very novelty. It was as a result of these studies that he was awarded the degree of D.Sc. of the University of London.

In 1907 he joined the late Sir Grafton Elliot Smith in anthropological studies on behalf of the Egyptian

Archæological Survey of Nubia, and in 1909 he was appointed lecturer in anatomy in the University of Manchester. His subsequent academic career was varied as well as distinguished, for he occupied chairs successively in the Universities of London, Adelaide, Hawaii, Melbourne, Manchester and the Royal College of Surgeons, and also (for one year) acted as director of anatomy at the Pekin Union Medical College.

A man of many and varied experiences, Wood Jones was imbued with a restless curiosity which found expression in several books of essays on a great diversity of subjects. His pleasing literary style and descriptive powers, combined with a certain originality of approach, made his writings singularly attractive and stimulating; this was particularly so with his lighter essays, but it was also true of his more serious expositions, even though the intrusion here and there of his personal prejudices against some of the well-established principles of evolution occasionally proved exasperating to those who allowed themselves to be too easily exasperated by such expressions of 'unorthodoxy'. In one of his earliest books, "Arboreal Man", published in 1916, Wood Jones elaborated in a series of anatomical essays the thesis (which he continued to emphasize in many of his later works) that, compared with other Primates, man is fundamentally primitive in many details of his anatomical structure. Indeed, it was this general conception which led him to suppose that man has occupied a rather unique position in the evolutionary series, for he argued that the retention of these primitive features could only be explained on the basis of a very prolonged period of evolutionary independence. In a more comprehensive work on "Man's Place among the Mammals", published in 1929, he further elaborated these ideas, contending with considerable dialectical skill that man's relationship to other Primates is far more remote than is suggested by the evidence of comparative anatomy and palæontology. It is fair to say that, although the more extreme views put forward by Wood Jones made but little impact on biological thought, he certainly provoked his contemporaries by the very persuasiveness of his literary style to give more critical attention to the validity of the evidence on which he relied.

Apart from his essays and books, Wood Jones's most important contributions to anatomy are embodied in numerous papers which have appeared from time to time in the *Journal of Anatomy*, the *Proceedings of the Zoological Society*, and elsewhere, and which consist mainly of descriptive studies in the field of comparative anatomy. But he also made important contributions in the allied fields of embryology, physical anthropology and palæontology. All these papers are characterized by a refreshing originality and by illuminating interpretations of the relationship between structure and function. His most systematic study (and in some ways one of his best works) was his comprehensive survey of the mammals of South Australia, published in the series of handbooks issued during 1923–25 by the South Australian Branch of the British Science Guild. Like all his published works, these are illustrated entirely by his own drawings, which display particularly well the unusual skill and attractive style of his draughtsmanship. In his two books on human anatomy, "The Principles of Anatomy as seen in the Hand", first published in 1920, and "Structure and Function as seen in the Foot", published in 1944, Wood Jones showed a profound knowledge of topographical and morphological detail, and at the same time gave abundant evidence of the exceptional powers of observation which enabled him to contribute so much original information beyond the scope of the standard text-books of anatomy. They also display his intimate acquaintance with the history and literature of anatomical discovery, for he makes constant reference in them to observations of the older anatomists which seem too often to have been forgotten.

In temperament, as well as in his scientific work, Wood Jones was an individualist, and he was sometimes impatient of new orientations in anatomical teaching and research. But it would be difficult to over-estimate the service which he has done to his subject by his insistence on the comparative and functional approach to anatomical studies, by the cumulative importance of his many original observations, and by the inspiration which he gave to his contemporaries and his students through his lectures and essays.

Prof. Wood Jones is survived by his widow, Gertrude Clunies, daughter of the late George Clunies-Ross, governor of the Cocos-Keeling Islands.

W. E. Le Gros Clark

Sir Roderic Hill, K.C.B.

Sir Roderic Hill, rector of the Imperial College of Science and Technology, London, died on October 6 at the age of sixty.

In 1948, the Governing Body of the Imperial College appointed a committee to select a new rector, and also invited representative members of the academic staff to consult among themselves and make suggestions. The result was unexpected: both groups independently suggested Air-Chief Marshal Sir Roderic Hill. Seldom can an appointment have been so acceptable to all concerned or have proved so happy in its outcome.

From the moment he took office, it was clear that the new rector would prove a powerful leader, and that his personality and example would stimulate those who came in contact with him to give of their best to the College. A humanist by education, he had, during his long career in the R.A.F., showed judgment and experience in technological matters which many professional engineers and scientists might well have envied, and the appreciation by his colleagues that he possessed such ability lent added weight to his view, so often expressed, that the education of technologists must be broadened if they were to exercise their functions with a full sense of responsibility. His concern with this aspect of education led him to initiate general lunch-hour lectures twice a week throughout the session, covering a wide range of subjects, a particular example being the encouragement of College musical activities by the appointment of a distinguished musician as special lecturer and adviser.

The general scheme, of which this was part, was given the title 'Touchstone', which will remain one of many reminders of the ideals of its originator. Under this scheme, also, week-end study circles were held at Silwood Park, the College Field Station near Ascot, at which students, members of the staff, and experts from outside the College met to discuss social and political questions of the day.

While this and much more was being developed, Hill carried a heavy burden in connexion with the

projected expansion of the Imperial College at the behest of the Government. The opportunities thus presented appealed to his imagination and he threw himself into planning and directing with that energy which he always gave so lavishly.

It was a great joy to him when, in 1953, he was elected vice-chancellor of the University of London, a post which his father, Prof. M. J. M. Hill, had held many years earlier. Some of his friends feared that the responsibilities of this post added to those he already carried might prove too great a strain and, in fact, his health obliged him to resign the vice-chancellorship before the completion of his year of office.

His career before he joined the Imperial College will be recorded elsewhere, and it is only possible to say here that the ability, enthusiasm, capacity for hard work, and keenness in everything he did, which produced an outstandingly distinguished R.A.F. officer, were all brought to the service of the College and the University. All these qualities and one other, which will be remembered most by all of us, that of charming friendliness, combined to give the College a rector who will always be remembered with deep affection. A. J. Sutton Pippard

Prof. Carl I. Cori

The death occurred in Vienna on August 31 of Carl I. Cori, emeritus professor of zoology in the German University of Prague. Born almost ninety years ago in Brüx, Bohemia, he studied zoology and medicine at the ancient German University of Prague and after graduation became assistant and lecturer at the Zoological Institute under Hatschek. In 1898 he was made a professor and director of the Zoological Station of Trieste, where up to 1914 he organized biological and marine research. Pupils from many countries came to his station, and the cruises of the research vessel *Adria* which Cori himself had helped to design, and of which he was the master, are still remembered by many biologists. After the First World War, which he spent in charge of a malaria unit, he found his station closed down and he returned to Prague, where in 1919 he became professor of zoology. Three times elected rector of the German University, he retired in 1936 and had lived in Vienna since 1946.

Cori's most important publications concerned the Phoronids and Bryozoa. The chapters in Bronn's "Klassen und Ordnungen" referring to these two groups, as well as to the Brachiopoda and Entoprocta, were also written by him. Further important papers dealt with segment formation in annelids and vertebrates, the circulatory system of *Ammocoetes* and with the fauna of the Adriatic. Cori also contributed in many ways to marine and limnological research techniques. Of several books, one, "The Naturalist's Introduction to the Adriatic Littoral", appeared in several editions.

Prof. Cori is survived by a son, the well-known biochemist, C. F. Cori, of St. Louis, Nobel Laureate in 1947 for medicine, and by two daughters, one of whom is married to the Viennese geneticist, F. Mainx.

The institutions at which Cori was prominently working have been destroyed by two world wars, but his teaching and personality will be remembered by his pupils in many countries. H. Kalmus

NEWS and VIEWS

European Organization for Nuclear Research

President of Council : Sir Ben Lockspeiser, K.C.B., F.R.S.

At the first session of the European Organization for Nuclear Research, held in Geneva on October 7, Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research in Great Britain, was elected president of the Council of the Organization, in succession to M. Robert Valeur. M. Valeur, who has been director of the Interim Council of the Organization since 1953, is a member of the French Diplomatic Service and has recently been appointed director of the Information and Cultural Services of the French Embassy in Washington. Sir Ben has from the beginning taken an active part in the work of the Interim Council of the Organization as a delegate of the United Kingdom and as chairman of the interim finance committee since 1953. After holding successively a number of key appointments in Britain in the field of aeronautical research, he became chief scientist to the Ministry of Supply in 1946, and, in 1949, secretary to the Department of Scientific and Industrial Research (see *Nature*, **163**, 314; 1949). He thus brings to his new post a wealth of experience both as a research worker and administrator.

Deputy Director-General : Prof. E. Amaldi

The new deputy director-general of the European Organization for Nuclear Research is Prof. Edoardo Amaldi, who was born in Piacenza in 1908. He has spent much of his time working at various laboratories throughout the world. Though he has studied the spectroscopy of atoms and molecules, his main work has been devoted to nuclear physics, particularly the diffusion and absorption of neutrons and the radioactivity induced by neutrons; in collaboration with Enrico Fermi he published a study of slow neutrons which has proved to be of fundamental importance for research in this whole field. During the past few years he has worked mainly on cosmic rays, especially the properties of mesons of high energy, the tau and kappa mesons and hyperons. He became professor of experimental physics in the University of Rome in 1937, director of the Institute of Physics in 1950, and is a member of the Accademia Nazionale dei Lincei. Prof. Amaldi is one of the pioneers of the European Organization for Nuclear Research. As secretary-general of the Organization since its creation in 1952, he has been responsible to the Council for the work of the Executive Group, which prepared the plans and the budget for the future. The energy with which he has applied himself in the service of the Organization has been an important factor in its growth to a fully fledged body.

Director : Prof. F. Bloch

The post of director of the European Organization for Nuclear Research has been filled by Prof. Félix Bloch, who took up his duties on October 1, on leave of absence from Stanford University, California. Prof. Bloch was born in Zurich in 1905 and started his university career there as a student of engineering

at the Eidgenössische Technische Hochschule. Very soon however, partly inspired by Schrödinger's lectures, he changed over to theoretical physics, and in 1927 moved to Leipzig, where as a pupil of Heisenberg he was awarded his doctorate for a dissertation on the quantum mechanics of conduction electrons. After working successively under Pauli, Heisenberg, Bohr and Fermi, he went to Stanford in 1934 as associate professor of physics, where in 1939, in collaboration with Alvarez, he made the first measurement of the magnetic moment of the neutron, using the cyclotron at Berkeley. In 1946 Prof. Bloch published the theory and, together with a number of collaborators, the experimental technique of measuring very accurately nuclear magnetic moments by the method of 'nuclear induction'. For this he was awarded the Nobel Prize for Physics in 1952 jointly with Prof. E. M. Purcell, who had done independent work in the same field (see *Nature*, **170**, 911; 1952).

Director of the Synchro-cyclotron Division : Prof. C. Bakker

Prof. Cornelis Jan Bakker has been appointed a member of the Directorate and director of the Synchro-cyclotron Division. Prof. Bakker was born in 1904 and studied physics under Zeeman in Amsterdam, taking his doctorate in 1931 for work on the Zeeman effect in the spectra of the noble gases. After this he spent a year in London at the Imperial College of Science and Technology continuing his work in the field of spectroscopy. He then joined the scientific staff of Philips at Eindhoven, where he did research on certain physical problems in relation to radio. However, his interests turned to nuclear physics and during the Second World War, in collaboration with Prof. Heyn, he started designing a cyclotron for Philips. In 1946 he succeeded Gorter as professor of physics and director of the Zeeman Laboratory of the University of Amsterdam and also became director of the Institute of Nuclear Physics, the focal point of Dutch nuclear research, sponsored by Fundamenteel Onderzoek der Materie (F.O.M.), by the city of Amsterdam and by Philips. There he and his team of assistants work with the cyclotron which was designed and built by him for Philips. Prof. Bakker is a member of the Dutch Reactor Committee and, as such, a member of the Joint Dutch–Norwegian Committee, which operates the joint reactor at Kjeller in Norway; he is also secretary of the Joint Committee on Spectroscopy of the International Union of Pure and Applied Physics and the International Astronomical Union. He was one of the original eight experts invited in 1951 to draw up plans for the future of the European Organization for Nuclear Research, and since 1952 he has been director of the Synchro-cyclotron Group; with about fifteen staff members and consultants he has been carrying out the engineering studies on the synchro-cyclotron. The new Division has begun moving to Geneva, but at the moment Prof. Bakker is only spending part of his time with it.

College of Aeronautics : Prof. J. A. J. Bennett

The Board of Governors of the College of Aeronautics has appointed Dr. J. A. J. Bennett to be professor of aerodynamics in succession to Prof. A. D. Young, who has taken the chair of aeronautical engineering at Queen Mary College, University of London (see *Nature*, January 9, p. 64). Prof. Bennett, who holds the degree of D.Sc. of the University of Glasgow and the diploma of the Imperial College of Science and Technology, London, is an international authority in the field of helicopters. He has been a member of the Helicopter Committee of the Aeronautical Research Council since 1945 and has served on a number of British missions devoted to rotary-winged aircraft. He was the originator of the Gyrodyne, which established an international speed record in 1948. A very considerable number of papers on rotary-winged aircraft have appeared under his name in technical journals both in Great Britain and abroad. Prof. Bennett is a founder member of the Helicopter Association and a member of the Council, and a founder member of the American Helicopter Society. For the past two years he has been engaged on helicopter research at Hiller Helicopters, California, and, prior to this, he was for seven years head of the Helicopter Branch of Fairey Aviation Co., Ltd.

H. W. B. Roozeboom (1854–1907)

Hendrik Willem Bakhuis Roozeboom, who is remembered in the history of physical chemistry for having demonstrated the industrial importance of the phase rule, was born in the historic town of Alkmaar on the North Holland Canal, a century ago, on October 24, 1854. His interest in chemistry began in his school-days; but he was too poor to go to a university. In 1875 he was offered a position as assistant analyst by J. M. van Bemmelen, and three years later he became an assistant in the chemical laboratory of the University of Leyden. He obtained the Ph.D. of this university in 1884, and in 1890 was appointed lecturer in chemistry. In 1896 he succeeded J. H. van 't Hoff in the chair of inorganic and physical chemistry in the University of Amsterdam. In 1875 the American physicist, Josiah Willard Gibbs, contributed to the *Transactions of the Connecticut Academy* his classic "On the Equilibrium of Heterogeneous Substances", which established the phase rule for chemical equilibrium and change. Roozeboom made careful studies of melting points and solubilities, while investigating the equilibria between solid and liquid phases in various systems, and in 1904 began publication of "Die heterogene Gleichgewichte vom Standpunkt der Phasenlehre". Completed in 1918, after his death, by his pupils, this work, particularly on the composition of the salt hydrates, showed the practical value of Gibbs's rule. Roozeboom died on February 8, 1907, at the age of fifty-three.

Scientific Instruments from the Thirteenth to the Nineteenth Century

Astrolabes, armillary spheres, portable sundials and other antique scientific instruments constitute a valuable source for the historian of science. They afford evidence which is complementary to the printed and manuscript material, and they may provide information unobtainable in any other way. Besides all this, they are frequently beautiful objects in themselves—products of a happy marriage of scientific design and the art of the metal-worker and engraver. The most important private collection of such instruments, that of Mr. J. A. Billmeier, of London, is described in the October issue of *The Connoisseur* by Dr. C. H. Josten, curator of the Museum of the History of Science, Oxford. The greater part of the collection was recently acquired from M. Henri Michel, of Brussels, well known for many years as a leading authority and connoisseur

in this field. The 153 choice instruments which have now come to Britain, together with the museum collections at South Kensington, the National Maritime Museum, the British Museum, the Whipple Museum at Cambridge and the Museum of the History of Science at Oxford, constitute a tremendous national heritage. Nowhere else in the world is such an aggregate of fine collections available for study. Dr. Josten's article is well illustrated with photographs of many of the instruments, including six of the twenty-one astrolabes and an interesting selection of sundials. A fuller account has been given in a printed Catalogue of the Billmeier Collection, which was exhibited in May 1954 by Messrs. Frank Partridge and Sons, London.

Mycorrhizal Uptake and Translocation of Phosphorus

In investigations of the uptake of phosphate by excised mycorrhizal roots of the beech, J. L. Harley and J. K. Brierley have obtained evidence of the active transport of this nutrient from the fungal sheath into the host tissue (*New Phytol.*, **53**, 2, 240; 1954). They point out that movement of substances from the external solution might be by way of the inter-hyphal spaces, or the walls of the fungal tissue, or through the living hyphæ themselves. In critical experiments, excised mycorrhizal roots were allowed to absorb radioactive phosphorus during the first phase while, during the second phase, the distribution of the radioactive phosphorus in the fungal and host tissue was determined after known time periods under conditions in which the rate of metabolism was varied. The rate of movement of phosphorus-32 from fungus to host was at first rapid, but became slower after 10–15 hr.; it was sensitive to temperature and oxygen supply. In low oxygen concentrations and in anaerobic conditions especially, phosphorus-32 was lost from the roots into the washing solution at normal temperatures. No such losses occurred at low temperatures in either aerobic or anaerobic conditions nor at normal temperatures in air. The loss of phosphorus-32 from roots in anaerobic conditions was entirely from the fungal tissue and resulted from a process which had a high temperature coefficient. In roots which had been returned to normal temperatures after a period of washing at low temperatures or returned to aerobic conditions after a period of washing in anaerobic conditions, transport of phosphorus from fungus to host, temporarily prevented, was resumed at an undiminished rate. The authors conclude that active transport of phosphorus from fungus to host occurs in mycorrhizal beech roots. The mechanism of transport is dependent upon aerobic metabolic processes in the fungal tissue as well as upon the absorptive processes of the core. The phosphate which is lost from roots kept in low oxygen concentrations is entirely released from the sheath and results from temperature-sensitive anaerobic processes occurring in that tissue. (See also *Nature*, October 9, p. 684.)

Abnormal Plant Growth

The Brookhaven National Laboratory, Upton, New York, has rendered a useful service to botany by bringing together a number of leading research workers interested in the phenomena of abnormal and pathological plant growths and their causation ("Abnormal and Pathological Plant Growth", Brookhaven Symposia in Biology No. 6; pp. 303, Office of Technical Services, Dept. of Commerce, Washington 25, D.C., 1954; 2.10 dollars). While the subject itself is not new, it is evident from a reading of this report that the application of recent and new techniques has resulted in the acquisition of many new and interesting facts and in a persistent analytical approach to the underlying causation of the several manifestations of abnormal growth. The symposium covers a wide field, and abnormal growth developments induced by physical, chemical and biological agents are described and discussed with special reference to their genetical, physiological and morphological aspects. In this diverse assemblage of new information the reader may read at large or he may read selectively, paying special attention to such major topics as differentiation and organogenesis, tissue culture and tumour formation as induced by genetical, bacterial, virus or insect agencies. Some of the investigations are reported in considerable detail, special reference being made to the method of induction of the abnormal development and to the related nutritional aspects. The substance of the discussion on each of the papers is also given.

Notes on Nuclear Science

A set of notes on nuclear science, mainly factual and explanatory, providing reliable data and references suitable for lecturers and teachers has been compiled by the Atomic Sciences Committee of the Association of Scientific Workers. The notes, which are in loose-leaf form, are in three sections, of which Vols. 1 and 2, dealing with scientific and industrial aspects, and the military aspect, respectively, have recently been issued; and Vol. 3, on international control, is to be issued shortly. In order to keep the notes up to date, it is intended to issue annual supplements to the respective volumes as the necessity arises. Vol. 1 is of a general nature and summarizes the basic elements of nuclear science, the large-scale release of nuclear energy, nuclear energy programmes in different countries and the production and uses of radioactive and stable isotopes. Vol. 2 deals with the effects of atomic weapons, in particular with the physical and biological effects of the bombs dropped on Japan in 1945, and with the problem of civil defence. A very detailed bibliography is a feature of this volume, and an addendum brings the information and data, on thermonuclear bombs, for example, up to the date of publication, September 1953.

South African Museum: Report for 1953–4

The report of the South African Museum, Cape Town, for the year ended March 31, 1954 (from the Museum; pp. 28), records that, with the prospective legislation repealing the South African Museum Act of 1857 and the proposal to include museums and other organizations as State-aided institutions, it is hoped that the future of the South African Museum will be as progressive as it has been in the past. A preliminary survey of the site for the extension of the east wing has been made, and the trustees hope for the erection of this long-deferred addition. It is intended that it shall provide extra space for the larger mammals and also for historical objects. In Britain all strandings of whales are immediately reported by the coastguards to the British Museum (Natural History). Unfortunately, in South Africa there are long stretches of coast where such occurrences are never seen or reported, and the Museum is taking active steps to remedy this position. Research is now considered to be a major function

of museum staffs, and the impressive list of publications, including those in the *Annals of the South African Museum*, bears witness to extensive activity in this direction.

Radiation Hazards in Industry: Conference in London

THE third conference of the British Occupational Hygiene Society will be a one-day meeting on "Radiation Hazards in Industry", to be held in the London School of Hygiene and Tropical Medicine on November 1. The conference is open to non-members (on payment of a fee of one guinea) as well as to members of the Society. The chair will be taken by the president of the Society, Prof. E. J. King, professor of chemical pathology in the Postgraduate Medical School, University of London. Four papers will be presented as follows: the health of workers exposed to ionizing radiation, by A. S. McLean, principal medical officer, Department of Atomic Energy; radiation safety in the Industrial Group of the Department of Atomic Energy, by D. R. R. Fair, head of the Health Physics Division, Department of Atomic Energy, Windscale Works, Sellafield; protection against X-rays and gamma-rays in the industrial field, by W. Binks, Radiological Protection Service, Ministry of Health and Medical Research Council; and safety criteria in atomic energy, by F. R. Farmer, assistant director (production), Department of Atomic Energy, Industrial Group Headquarters, Risley. There will be a short discussion after each paper. The conference will be reported, in due course, in the *British Journal of Industrial Medicine*. Those intending to be present should complete and return by October 25 the appropriate form, obtainable from the honorary treasurer, Mr. D. E. Hickish, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Biology and a General University Education

A RESIDENTIAL conference is being arranged by the Institute of Biology in co-operation with members of the staff of the University College of North Staffordshire on the place of biology in a general university education. The meeting will take place at the University College of North Staffordshire during December 19–21. Part of the programme will revolve around the place of biology in a general science course at university-level, while the remainder of the programme will be concerned with the place of biology in a university education which is not primarily scientific. Among those expected to take part will be Dr. J. Hutchins, professor of physiology in the University of Chicago, who has been closely concerned with the planning and teaching of a course in biology for arts students, Prof. S. Zuckerman, Prof. A. R. Gemmell, Dr. C. Gordon, Mr. L. J. F. Brimble, Mr. W. B. Yapp, Prof. J. F. Danielli, Prof. T. A. Bennet-Clark and Prof. F. W. Rogers Brambell. Further information can be obtained from the Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

Fourteenth International Congress of Pure and Applied Chemistry, Zurich

THE dates of the Fourteenth International Congress of Pure and Applied Chemistry and the Eighteenth Conference of the International Union of Pure and Applied Chemistry, both of which will be held in Zurich, are July 21–27 and July 20–28, 1955, respectively (and not the other way round, as given in *Nature* of September 25, p. 588). Papers will be limited to twenty minutes and summaries not exceeding 250 words should be submitted via the appropriate national organization. The final dates of acceptance vary for the different countries from December 15 and January 31, but in any event the summaries must reach the Congress secretary-general by February 15.

Announcements

THE Committee of Privy Council for Agricultural Research and Nature Conservation has appointed Mr. Frank Rayns to fill a vacancy in the membership of the Agricultural Research Council, caused by the retirement of Prof. K. Mather. Mr. Rayns is director of the Norfolk Agricultural Station, Sprowston; he is chairman of the Experimental Husbandry Committee of the Agricultural Improvement Council for England and Wales and serves on the governing body of the National Institute of Agricultural Engineering. Prof. S. Zuckerman has been appointed a member of the Agricultural Research Council for a further term of office.

DR. NICOL GROSS, managing director of S.A.G. (Pty.), Ltd., Johannesburg, has been appointed to the University of London readership in production engineering tenable at the Imperial College of Science and Technology.

MR. IVOR BOWEN has retired from the post of principal director of Equipment Research and Development (Air) in the Ministry of Supply, and is taking up an appointment with the General Precision Equipment Corporation of the United States; his new post will be in London.

THE Third International Congress on Vitamin E will be held in Milan in September 1955. The following topics will be discussed: vitamin E and metabolic processes; influence of vitamin E on the hæmato-vascular system; vitamin E and the neuromuscular system; correlation between vitamin E and other vitamins and hormones. Further information can be obtained from Prof. Emilio Raverdino, via Pietro Verri 4, Milan.

THE Rockefeller Foundation has made a grant of 7,500 dollars to the University of Glasgow towards the expenses of three small working conferences of European scientists interested in genetical problems. The conferences will be held during the next five years, one probably in or near Glasgow and the others in localities to be decided.

THREE postdoctoral fellowships in statistics are being offered for 1955–56 by the University of Chicago. The purpose of these fellowships (of value 4,000 dollars each) is to acquaint established research workers in the biological, physical and social sciences with the role of modern statistical analysis in the planning of experiments and in the analysis of empirical data. Application forms can be obtained from the Committee on Statistics, University of Chicago, Chicago 37, and must be returned by February 15, 1955.

ERRATUM. In the communication "Seasonal Regulation in British Dragonflies" by P. S. Corbet in *Nature* of October 2, p. 655, the labelling of the axes of the graph should be interchanged; thus the ordinates indicate percentage of yearly population emerging per day, and the abscissæ successive days of emergence.

ORGANIZATION OF APPLIED RESEARCH IN EUROPE

THREE reports have been prepared by the Organization for European Economic Co-operation*, the first two of which embody the results of a study of the organization of applied research in various European countries, including the United Kingdom, made during October 6–November 15, 1951, and in the United States and Canada during April 21–June 11, 1952, by two Technical Assistance Missions, the comparative observations and general conclusions of the two Missions being collected in the first report. The third report, dealing at length with applied research in the United States and Canada, though undertaken at the request of the Organization for European Economic Co-operation, was prepared as a project of the National Research Council of the United States National Academy of Sciences, in co-operation with the Mutual Security Agency. To a certain extent it has since been superseded by studies carried out by the National Science Foundation, so far as applied research in the United States is concerned, with which roughly a hundred out of its hundred and twenty-five pages deal. Nevertheless, the broad sketch of American practice in the organization, administration and finance of applied research and of the methods used to facilitate the translation of research results into practice provide a most useful supplement to the earlier publications of the National Resources Planning Board, "Research—A National Resource", and to the Steelman report, "Science and Public Policy". It is supported by a brief but well-chosen bibliography, and the much slenderer survey of industrial research in Canada is equally well-balanced and appropriate to the purpose.

The volume on applied research in Europe contains much more material that is either fresh or—except perhaps in respect of that supplied for the United Kingdom or contained in papers presented to the international symposium sponsored by the Department of Scientific and Industrial Research in London in November 1951—not so conveniently accessible. The symposium was included in the programme of the first of the two missions, and a brief account of the symposium is included in the Mission's report, which emphasizes the value of comparing methods used in the various countries for the organization of research, particularly for the adaptation of new ideas to varying conditions, and the value of international collaboration in the effective distribution of technical information. More attention should be given to the application of research results and to the improvement of means of communication. Generally, in Europe the trend has been in favour of the co-operative research organization as opposed to the sponsored research institute; but both types are regarded as necessary, and there appears to be no reason why they should not work in harmony.

In Austria, the Federal Government, which is the chief supporter of basic research, provided 390,000 dollars for this purpose at the universities and technical colleges during 1952 as well as other contributions for basic and applied research and technical development to a total of 1,960,000 dollars, but only 58,600 dollars was provided for basic research from industry or other private sources. There are some three hundred and fifty experimental research stations in Austria, employing eight hundred graduate and nearly five hundred other staff, and two centres for disseminating technical information: the Documentation Centre for Technology and Economy and the Economic–Technological Service of the Austrian Productivity Centre.

Since the Second World War scientific research in Belgium has been organized mainly by the National Scientific Research Board, with an income during 1949–50 of 306,000 dollars (187,000 dollars from State grants) and the Institute for the Development of Scientific Research in Industry and Agriculture with an income, from the State, in 1951 of 1,895,000 dollars. About 65–75 per cent of the industrial and agricultural research programme supported by the latter body is carried out at the universities or higher educational institutions, but for industrial research a higher proportion is carried out in the laboratories of the research associations.

Technical research in Denmark is mostly built up around the institutes of higher learning, but there are several research institutes established by the Government, and the Academy of the Technical Sciences makes grants totalling 192,000 dollars to various technical institutions, while the Government contributes 1,442,000 dollars for technico-scientific research, as well as 50,000 dollars for the Research Council of the Technical Sciences and 36,000 dollars for scientific research. The General Scientific Foundation has recently been established to distribute a State grant of 288,000 dollars annually for research in basic science and in the agronomic and veterinary sciences.

Applied research in France is carried out chiefly in laboratories controlled by the State, the nationalized industries and private enterprise. The National Centre of Scientific Research, with an expenditure of 8,580,000 dollars during 1951, as well as 1,720,000 dollars on equipment, is concerned mainly with fundamental research but devotes some of its activities to practical applications. Some branches of industry have organized corporate research centres, but the structure of these bodies varies widely.

In Germany the Kaiser Wilhelm Society has been replaced by the Max Planck Society for the advancement of the sciences, which has already some sixteen institutes dealing with applied research, and had an income for 1953 of 4,240,000 dollars. The German Research Association, which functions chiefly through grants to individual research workers, had funds in 1953 amounting to 2,600,000 dollars, while the Fraunhofer Society for the Advancement of Applied Research, founded in 1949 and which is still being built up, has distributed about 714,000 dollars for applied research. Research associations have been formed for some industries, to which the League of Benefactors for German Science has contributed some 238,000 dollars for fundamental research, while Federal Government contributions to industrial research totalled 6·25 million dollars.

* Organization of Applied Research in Europe, the United States and Canada. Report of Technical Assistance Missions Nos. 81–82–83. Vol. 1: A Comparative Study. Pp. 80. 6*s*.; 1 dollar; 300 French francs. Vol. 2: Applied Research in Europe. Pp. 192. 12*s*.; 2 dollars; 600 French francs. Vol. 3: Applied Research in the United States and Canada. Pp. 120. 8*s*.; 1.25 dollars; 400 French francs. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1954.)

The main government organization for sponsoring research in Italy is the National Research Council, with an income for 1952–53 of 3 million dollars, while it is estimated that about 2·3 million dollars a year is spent on research in the universities, another 2·7 million dollars by government departments and nearly 250,000 dollars by the learned societies, professional associations and scientific foundations. Estimates are given of the expenditure on industrial research by individual firms—for example, 924,000 dollars each by the Montecatini Co. on chemical research and by the Fiat Co. on mechanical engineering research—but not for industrial research organizations as a whole.

In the Netherlands the Central National Organization for Applied Scientific Research has been responsible since 1932 for the direction of applied research in accordance with national needs and had a budget for 1951 of 3·4 million dollars, of which 2·37 million dollars came from the government and the remainder chiefly from industry. In Norway, where the universities themselves come under the Ministry of Education, most scientific and technical research, apart from that at the Christian Michelsen's Institute, Bergen, and that of the Society for Industrial and Technical Research at the Norwegian Technical College, Bergen, is carried out directly, under the government or with government assistance, which provided about 8 million dollars for research and development during 1952–53. The Royal Norwegian Council for Scientific and Industrial Research is responsible for the furtherance of fundamental research as well as for planning technical research in accordance with the needs of industry. Expenditure on scientific and technical research in 1952–53 is estimated at about 8·2 million dollars, of which 1·8 million was in universities and technical colleges, 2·1 million in public research institutes, 630,000 in institutes under the Council for Scientific and Industrial Research, and about 2·5 million dollars in industrial laboratories, with a research staff of about nine hundred, of which 290 are in the universities and technical colleges and 182 in public research institutes.

Information on research expenditure in Sweden is much less complete. The Royal Swedish Academy of Science received government grants amounting to 243,000 dollars during 1951–52 for research work at the Nobel Institute for Physics and Chemistry, the Stockholm Observatory and other institutes under its control. The Royal Swedish Academy of Engineering Sciences received a government grant of 25,000 dollars and also support from industry. Of the four State Research Councils, that for Technical Research had a budget for 1951–52 of 212,000 dollars, the Committee for Building Research 67,500 dollars and the Atomic Energy Committee 367,000 dollars. Applied research is carried out to some extent by various government laboratories which have a total budget of nearly 1·3 million dollars, while the combined budgets of the Forest Products Research Laboratory, the Textile Research Institute, the Metallographic Institute and the Food Preservation Research Institute are 776,000 dollars, of which 235,400 dollars are provided by the State. A survey of thirty-seven of the larger industrial research laboratories indicated that they employed a scientific and technical staff of 340 out of a total of 2,300, and the total expenditure on industrial research is estimated at about 10 million dollars a year. The interchange of information between research workers and industry is facilitated by the Researchers Contact Organization.

In Switzerland applied research is organized at the national level through the Society for the Promotion of Research at the Federal Technical College, the Commission for the Sponsoring of Scientific Research, the Swiss Research Council for Atomic Energy and the Swiss National Foundation for Scientific Research. No comprehensive data are available for Federal expenditure on research, but 936,000 francs were allocated for scientific research by the Federal Council in 1945, and the Swiss Federal Institute of Technology in 1951 received Federal credits amounting to 2 million dollars, the Swiss National Foundation for Scientific Research was to receive Federal grants increasing to 936,000 dollars in its third year, while some 3·25 million dollars were expended in 1951 on research and development by the Division of War Technology of the Federal Military Department. It is estimated that the firms of Ciba and Sandoz spend about 5·85 million dollars a year on research, and Brown Boveri about the same amount. The Aluminium Foundation was established by the Aluminium Industrie A.G. of Nordhausen to support promising investigations in applied chemistry, particularly electrochemistry and electrometallurgy, and a number of other Swiss firms and industrialists have established foundations for scientific research in medicine, biology, etc.

BRITISH INDUSTRY AND SCIENTIFIC MAN-POWER

THE first part of the address of Sir Harry Pilkington, president of the Federation of British Industries, to the annual meeting at Reading, on September 21, of members of the Southern Region of the Federation, stressed the importance of the export trade to the British economy and indicated that we are on the eve of another big effort by the Federation in this field, the Trade Fair at Baghdad. He said that we are the people in the whole world whose future, safety and survival most depends on the growth of international trade, and on the credit side that means the export of manufactured industrial products. We must constantly improve our productivity, attempt to increase our share of world trade, but still more expand the total of world trade and develop the purchasing power of growing markets overseas, including the raising of the standard of living of those people whose standards are far below our own.

Sir Harry said that the new industrial revolution under way completely overshadows that of the nineteenth century, and means a demand for more, and more highly qualified, scientists. The Federation's Education Committee is concerned here both with recruitment and training, including the shortage of science teachers. We shall not obtain the rise in productivity we require, he thinks, unless we have more people with a good scientific background—not merely more outstanding inventors, but more people competent to carry out the ordinary analytical work and team-work of development. Sir Harry then emphasized the high cost of invention to-day. This is now the result of team-work and leadership, and often involves enormous sums before inventions are developed to a commercial stage. He does not believe that Britain or any other country can afford

to allow all its best scientists to work in isolated compartments on the same problem, without access at least to other people's mistakes. Broad views of the advantages of pooling resources of inventiveness, or of pooling results, are of the utmost importance to Britain and to mankind as a whole. He therefore urged industrial firms to re-assess the work of their research departments, and where research institutes or associations for the whole of the industry do not exist, to try to devise other means for pooling with their neighbours or their competitors results of their development work.

Sir Harry remarked that some of our man-power resources are still being used wastefully, and touching on the question of taxation said that to abolish de-rating would give a great shock to industrial confidence in Britain and undo all the good resulting from the encouragement given last April to investment in plant and machinery. He urged member associations and individual firms to make their own cases showing what would be the effect, industry by industry, of a re-introduction of full rating on top of revised valuations.

Although Sir Harry complained of the high level of employment in the Civil Service, he welcomed the endorsement by the Government and the Civil Service as a whole of the findings of Sir John Wood's Committee in the Crichel Down case, and said that it is equally important that private citizens, and especially industry, should show like consideration to Civil servants.

BRITISH PHARMACEUTICAL CONFERENCE, 1954

THE ninety-first British Pharmaceutical Conference was opened at Oxford on September 13 and nearly five hundred members attended.

Dr. H. Davis, in his chairman's address, discussed the impact of National Health Service on pharmacy and outlined how the changing pattern of prescribing and dispensing demands from the pharmacist of to-day less manipulative skill but a more detailed scientific knowledge of drugs and processes than was formerly required. This changing demand is reflected in the research papers read at the Conference.

Two of the papers are of general interest. The first, on demineralized water, shows that with correct technique demineralization of tap water by mixed anion and cation exchange resins produces a water of purity at least equal to that of distilled water B.P. The second general paper was a discussion of entrainment of liquid in distillation. It was shown that when the flow of vapour in the still-head was in streamline flow, the amount of entrainment increased with diameter of still-head and was proportional to Reynolds number.

Research of specific interest to practising pharmacists included a study of the *p*H of the castor oil soap in the preparation of a solution of chloroxylenol in an attempt to obtain a constant product. The increased use of newer emulsifying agents is reflected in the report on polyethylene-glycol esters of cetostearyl alcohol, in which it was shown that when used alone the lower members of the series (two or four ethylene oxide units) are more effective in emulsifying arachis oil. Also in the emulsion field, an interesting point was that the addition of bentonite to certain cream bases will permit them to be autoclaved without creaming or separation of the oil.

Stability of preparations of drugs is always an important subject in pharmaceutical analysis. A quick iodometric method for estimating the hydrolysis of succinylcholine chloride, confirmed by chromatographic and biological assays, has shown that increased temperature (20° → 37° C.) greatly increases the instability of this drug. Since ferrous iron is more readily adsorbed than ferric iron, oxidation of ferrous gluconate solutions should be prevented; it has been found, by suitable formulation and storage in light, that the ferrous iron content of such a solution may increase slightly, but this is accompanied by some deposition from the solution. The most stable solution is a 10 per cent solution stored in small, completely filled containers, stabilized with 7·5 per cent dextrose monohydrate and stored protected from light.

It is interesting to find that the sugar coating of tablets of penicillin intended for oral use not only masks the bitter flavour but also protects the contained penicillin from external moisture, and so increases the stability that they can then be stored for two years at 25° C.

The instability of tincture of digitalis has been a puzzle, since the frog lymph sac method of assay showed loss of potency on storage whereas the cat intravenous method did not. Fresh light has been thrown on this subject by two workers who, using a frog intravenous method, have shown that this method also indicates a drop in activity on storage and so the disagreement between the two methods of assay is not due to differences in absorption. They suggest that on storage the primary glycosides in the tincture are hydrolysed to secondary glycosides but not down to the genins.

The correlation shown between three methods of measuring pyrogenic activity—temperature rise, fall in percentage of small lymphocytes and fall in average number of lobes per neutrophil—will give pharmacologists a double confirmation of the results of pyrogen tests.

A very neat method of studying the percutaneous absorption of substances from ointment bases has been devised. Injection of acetylcholine into a rat causes secretion of reddish-brown tears; this effect is increased by eserine, and the response can be used for an assay of the eserine. By incorporating the eserine in an ointment base and rubbing on the skin of the rat, the amount absorbed can be ascertained.

A number of papers on the analytical aspect of research were presented, including biological and chemical assays.

In a new type of apparatus it has been shown that the rate of disinfection of solids by formaldehyde vapour is dependent on the amount of vapour permeating the solid rather than the concentration of formaldehyde in the vapour.

The adsorption of phenol on activated charcoal, or on a precipitate caused when ferric chloride was added to the bacteriological medium used for detecting survivors from a phenol–*Bact. coli* mixture, showed no apparent effect on the survival-rate.

An infusion of raspberry leaves has a traditional use in giving easy and speedy parturition. Preliminary investigation into the active principles which may be responsible for this effect have led to the separation of three fractions, one a spasmolytic factor which may antagonize the stimulant effect of the other two factors, and might explain the negative

results of clinical trials of raspberry leaf extracts. A standard method for the purification of such extracts should lead to more definite results from them.

The comparison of two types of assay for tincture of digitalis, the 18-hr. frog method and a chemical method using 3 : 5-dinitrobenzoic acid, has shown that the biological assay of this material is still the only sure way of ascertaining potency. Search for a means of characterizing sulphonamides by examination of their benzaldehyde and salicylaldehyde derivatives not only achieved the required results but also led to a rapid colorimetric method for the assay of sulphadimidine.

Two papers were read dealing with spectroscopy, one a general outline of infra-red techniques and the other on the determination of vitamin D.

The diverse chemical nature of synthetic analgesics led to a review of their stereochemistry, when it was found that the more analgesically active isomer of optical enantiomorphs has a spatial configuration related to that of D-(−)-alanine. The isolation, purification and identification of the constituents of the petrol extract of serpentary formed the basis of one paper, which illustrated the vast amount of work that still remains to be done before the true nature of many of the drugs in common use is elucidated.

Two new assay techniques were reported, one for benzathine penicillin and the other for quaternary ammonium compounds.

It was argued on statistical grounds that some of the present standards for surgical dressings given in the British Pharmaceutical Codex need review, in that in some cases the exacting specifications take no account of variations which are bound to occur in manufacture and can easily be measured and limits imposed.

With the increasing use of the tablet as a convenient method of dispensing solid drugs, it is not surprising to find the symposium session of the Conference devoted to tablets, when the preparation, standardization and dispensing of them were fully discussed.

GIOVANNI MARIA LANCISI (1654–1720)

ANATOMIST, pathologist, epidemiologist, sanitarian and clinician, and one of the most advanced thinkers in the history of the medical sciences, Giovanni Maria Lancisi was born in Rome three hundred years ago, on October 26, 1654. He studied medicine at the Collegio di Sapienza, where he obtained his doctor's degree at the age of eighteen. After serving for two years as assistant physician at the Santo Spirito Hospital, he was made a canon of the Church of San Salvatore College in 1678 and devoted himself to studying the medical classics. In 1684 he was appointed professor of anatomy at the Collegio di Sapienza and thirteen years later professor of the theory and practice of medicine. A great admirer of Boerhaave, he introduced his clinical methods into medical teaching. He was physician to three successive popes: Innocent XI, Innocent XII and Clement XI. It was at Clement's request that in 1707 he wrote his monumental treatise "De subitaneis mortibus", in which he carefully records the pathological lesions of the brain and heart observed at autopsy, gives the first description of syphilis of the heart and of growths on the valves, and lists hypertrophy and dilatation of the heart as a cause of sudden death.

Lancisi's book, "De motu cordis et aneurysmatibus" (1728), is another landmark in the history of heart disease, for it stresses the significance of heredity, syphilis and violent emotions as causes of aneurysm. In his work "De noxiis paludum effluviis eorumque remediis" (1717) he showed remarkable insight into the theory of contagion and the possible transmission of malaria by mosquitoes. He described the natural history of the mosquito, suggested repeated examination under the microscope of the blood of malarial patients, recommended with poetic fervour cinchona bark as a remedy, and pointed out the connexion between stagnant water and mosquitoes as vectors of the disease. For the prevention of malaria he advocated the draining of marshy lands and their drying up by conservation of forests. He also wrote on equine and bovine pest.

Appreciating the relation of anatomy to sculpture and painting, Lancisi, in 1691, persuaded Bernardino Genga, professor of anatomy and surgery in Rome, to publish for the use of students his studies of anatomy made from the works of the ancients, and he himself published and edited in 1714 the "Tabulae anatomicae" of Eustachius, which had lain unused in the Vatican Library for more than 150 years. In the following year he wrote "A Correct Curriculum of Medical Studies", in which he emphasized the need of a preliminary education and the value of regular visits to other medical clinics. His library of twenty thousand rare books and manuscripts (Biblioteca Lancisiana), which he presented to the Santo Spirito Hospital in 1711 for the use of young physicians and surgeons, and for the maintenance of which he left a generous legacy, represents one of the first public medical libraries.

Paradoxically, Lancisi, whose signature is writ large on so many pages of anatomy, is eponymously commemorated solely by Lancisi's nerves—striæ longitudinales on the upper surface of the corpus callosum.

A small man with lively expression and exuberant spirits, affable and diplomatic in company, Lancisi was a tremendous worker of amazing versatility, who carried on an extensive correspondence with the most famous scientists of his day. He died in Rome on January 21, 1720, at the age of sixty-six. In the tercentennial year of his birth he is gratefully remembered chiefly for having laid the foundation for a true understanding of the pathology of the heart.

W. R. Bett

SOCIETY FOR VISITING SCIENTISTS

ANNUAL REPORT FOR 1953–54

THE annual report for 1953–54 of the Society for Visiting Scientists, the seventh report of the Society, opens with an account of the financial state of the Society, which though it is disappointing is by no means hopeless, and under the energetic direction of the honorary treasurer, Prof. A. Haddow, fresh appeals will be made to the scientific industry to support the Society (preferably by deed of covenant) and to individual scientific workers to become members.

The Society's library and lounge are available to scientific societies on payment of a small fee, and

it is hoped that in future more use will be made of these facilities. The premises were redecorated during the year, and they have a very pleasing appearance. As a result of the financial stringency, a certain amount of economy in the activities of the Society has had to be enforced during the year, but receptions were arranged for the delegates to two conferences—one on nucleic acids, organized by the Faraday Society, and the other by the General Assembly of the International Union of Pure and Applied Physics—and members of the Bureau of the International Council of Scientific Unions were also received on the occasion of their meeting in London in the spring. Of the three evening meetings held during the year, one consisted of scientific films on the petroleum industry, and another was a lively discussion on "The Science of Clothing". The third gathering was prompted by the occasion of the meeting in London of the Executive Committee of the International Geographical Union, and a discussion was arranged on "World Population".

The Overseas Science Students Association, which was started two years ago with the help of the Student Department, Student Welfare Department and the Science and Engineering Department of the British Council, has continued to hold its regular weekly meetings.

Although there were few 'major' occasions, the principal function of the Society—to act as a day-to-day centre in London for all scientific workers, both from overseas and those resident in Britain—was maintained, for which no little credit is due to the secretary, Miss E. Simpson. The officers of the Society are: *President*, Prof. A. V. Hill; *Honorary Secretaries*, Prof. F. J. M. Stratton and Mr. A. Lang Brown; *Treasurer*, Prof. A. Haddow; *Chairman of the Programme Committee*, Mr. G. A. McMillan; and *New Member of Council*, Sir Lawrence Bragg.

BUILDING RESEARCH STATION

REPORT FOR 1953

THE report for 1953 of the Building Research Board, to which is attached the report of the director of building research, Dr. F. M. Lea, this latter taking up the major part of the publication (pp. 66. London: H.M.S.O., 1954; 3*s*. 6*d*. net), is chiefly impressive for the very great amount and variety of research that has been undertaken at the Building Research Station, Garston, near Watford. Perhaps this is not altogether surprising, since the staff at the Station numbers more than four hundred, half of whom are officers in the scientific and experimental grades.

The director's report is divided into seven sections entitled: materials; design and performance of structures; soil mechanics; building operations; efficiency of buildings; the Scottish Laboratory; and Colonial housing and building research. In materials alone, the problems are becoming exceedingly varied and complicated as more and more different sorts of materials are invented and developed. But, of course, building research does not end with materials. There are the various types of building, from small dwelling-houses to large industrial premises, and it is with regard to the latter that many interesting developments are taking place, particularly in such media as prestressed concrete. Then, too, there is the question of building methods, productivity and costs, and the development of mechanical aids in building, of which the rail-operated tower crane is a case in point. The scope of building research extends to such problems as flooding, sea-defence banks and dams.

The Scottish Laboratory is more and more providing a means of extending investigations at the main Station, though there are particular Scottish problems, such as the utilization of local stone. In Colonial research, the work revolves around the activities of the Colonial liaison officer, who has been making extensive tours, mainly in Africa, looking into problems and arranging for the right organization to work on them. As yet, the only body in Africa engaged exclusively on building research is the South African National Building Research Institute, but plans are being laid for building research to be undertaken in British West Africa, the French African Territories and the Belgian Congo, as well as a certain amount of work on materials in Kenya and Southern Rhodesia.

Finally, mention must be made of the Building Research Board's concern at the reduction in finance during 1953, which severely curtailed long-term and short-term research, leaving the resources more concentrated on advisory work and the practical application of research. The Board feels strongly that its function is to promote not only work of immediate use but also that which will yield returns in the more distant future, and it is to be hoped that the recent lifting of financial restrictions on the Department of Scientific and Industrial Research will be reflected in the allocations to building research.

PLANT CULTIVATION IN SALINE AND BRACKISH WATER

THE raising of plants under saline conditions is a common problem in arid areas, where there is little leaching of the soil by rainfall and where the water available for irrigation has often a high salt content. In the fourth volume produced under the Unesco Arid Zone Programme*, the utilization of saline water is dealt with in three reviews, which not only provide a useful summary of existing information, but also, by emphasizing the gaps in our knowledge, serve as pointers to further research.

The first review, by Georges Grillot, of the Centre de Recherches Agronomiques, Rabat, Morocco, is based on research carried out in Africa, Europe and the Middle East. It deals with the biological problems presented by the growth of plants in saline or alkaline environments, and includes a particularly thorough section on the use of saline water for irrigation. Some of the important data are concisely set out in nine appendixes, among which is a table of natural halophytes "indicative of the corresponding cultivability of domestic species". One of the principal conclusions of the review is that both research and actual practice show that irrigation by saline water is not necessarily harmful. Certain types of soil, however, may be impoverished by even slightly saline water; but since vegetation is tolerant of higher degrees of salinity, the problem is one for the soil chemist rather than directly for the biologist.

* Arid Zone Programme. Reviews of Research on Problems of Utilisation of Saline Water. Pp. 96. (Paris: Unesco; London: H.M.S.O., 1954.) 1·75 dollars, 500 francs, 10*s*. 6*d*.

The second review is by Dr. H. E. Hayward, director of the United States Salinity Laboratory, Riverside, California, and covers research in the Americas, Australia and India. The practical problems encountered in the various geographical regions receive a comprehensive treatment; but more space is allotted to an interesting general account of basic physiological problems. Subjects discussed include the physiological basis for salt tolerance, the physiological basis for alkali tolerance, the effect of saline and alkali soils on plant growth, toxic effects of specific ions and salt tolerance in relation to germination. It is concluded that one of the main effects of moderate levels of soil salinity is to limit water supply to the plant by increasing the osmotic pressure of the soil solution. This effect is intensified by an increase in soil moisture tension, and the combined effect, total soil moisture stress, conditions the growth of plants. Over and above the osmotic effect, each component of the saline solution may have some specific toxic effect which may vary among various genera, species and varieties of agricultural crops. Because of this specificity in salt tolerance, it is important to make a proper selection of crops for use on lands that are marginal because of salinity.

The third review, by Dr. Everett D. Howe, of the Faculty of Engineering, University of California, is restricted to a consideration of methods of purification of salt and brackish waters. The development of an economically feasible method of carrying out such a purification on a large scale is clearly of the greatest importance, but has evidently not yet been achieved.

The reviews are clearly written and although their main value will be to those engaged in the agricultural development of saline regions, they have much of interest for many readers, particularly for the plant physiologist or ecologist.

A. Allsopp

HOUSEFLIES RESISTANT TO A GROUP OF CHLORINATED HYDROCARBON INSECTICIDES

By Dr. J. R. BUSVINE

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In general, DDT has been the subject of far more research than other chlorinated hydrocarbon insecticides and, in particular, this is true of investigations of insecticide-resistance in houseflies. It seems that resistance to the insecticides γ-BHC, chlordane, dieldrin, aldrin and toxaphene is quite distinct from DDT-tolerance. These compounds must have some factor in common, since selection by exposure to one of them raises the resistance of a fly strain to the others. Questions which now arise are: Is there a single defence mechanism which protects resistant flies from all these compounds; and what is the common factor which defines this group of insecticides?

As regards DDT tolerance, there is evidence of at least two defence mechanisms, which may be more or less developed in different strains of fly, and thereby modify the type of resistance displayed. This has been exemplified by two strains of DDT-resistant flies, which showed marked differences in relative susceptibility to a range of DDT analogues[1].

It seemed possible that a similar type of investigation might reveal whether resistance to the γ-BHC–chlordane group of chlorinated compounds was equally heterogeneous. The method used was to determine the exact degrees of resistance, to a series of related compounds, shown by four strains of flies from very different sources. The strains of houseflies used were: (1) Sardinia strain. Previous history in the field: DDT house-spraying throughout the island during 1947–50; chlordane added to the spray from 1948; laboratory colony started in November 1950. (2) England strain. Previous history in the field: from a refuse tip at Egham, treated with DDT during 1947–49; during 1951–53 treated with BHC; laboratory colony started in September 1953. (3) Omdurman (Sudan) strain. Previous history in the field: all pit latrines and other breeding sites near the town dusted with BHC during 1949–52; in 1950, many houses sprayed with DDT; laboratory colony started in March 1953, through the kindness of Dr. D. J. Lewis. (4) Uruguay strain. Previous history in the field: widespread use of BHC and DDT; laboratory colony started in 1951; a subcolony kindly sent to me by Mr. Newman, of Imperial Chemical Industries, Ltd., in January 1954. (5) Normal strain. Reared in the laboratory for many years and believed to be normally susceptible to insecticides.

Samples of males of the above strains were collected and, on the fresh specimens, the ratios head width/frons width were calculated, with the following results: Sardinia, $6{\cdot}81 \pm 0{\cdot}44$; England, $5{\cdot}98 \pm 0{\cdot}38$; Omdurman, $10{\cdot}94 \pm 1{\cdot}45$; Uruguay, $5{\cdot}17 \pm 0{\cdot}46$; normal, $5{\cdot}14 \pm 0{\cdot}46$. The Omdurman strain is clearly of the *M. domestica vicina* type, while the England, Uruguay and normal colonies are of the *M. domestica domestica* form. The Sardinia ratio is a little high, but approximates to the latter. These figures agree with those of Sacca[2], though I find the difference between colonies of *domestica* and *vicina* to be more constant than he suggests. Thus, after a year in my laboratory, the Omdurman ratio was found to be $11{\cdot}14 \pm 1{\cdot}40$, so that it had not changed appreciably.

Measurements of relative resistance. Purified samples of the following seven compounds were kindly supplied by the Shell Co., Ltd.: α- and β-chlordane (1, 2, 4, 5, 6, 7, 8, 8-octochloro-4, 7-methano-3*a*, 4, 7, 7*a*-tetrahydroidane); it is believed that α- and β-chlordane differ in regard to the position of chlorine atoms on carbons 1 and 2, α being a *trans*-

Table 1. Median Lethal Concentrations of Various Insecticides to Different Strains of Housefly

Fly strain	Median lethal concentration (per cent)							
	Chlordane							
	alpha	beta	Isodrin	Endrin	γ-BHC	Aldrin	Dieldrin	DDT
Uruguay	30	9	0·5	0·3	0·8	7	3	0·35
Omdurman	18	4	0·35	0·2	0·5	2	1·5	0·6
Sardinia	3·5	0·3	0·1	0·05	0·09	0·4	0·25	1·8
England	2·0	0·4	0·09	0·06	0·1	0·23	0·14	1·0
Laboratory	0·04	0·018	0·015	0·009	0·008	0·007	0·005	0·08

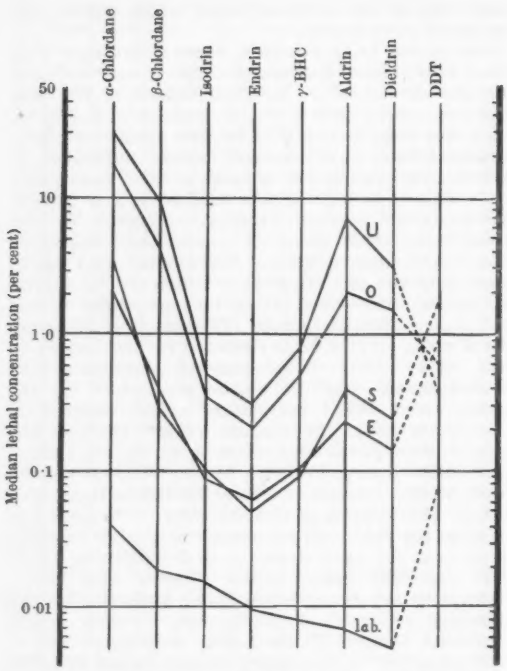

Fig. 1. Relative resistance to chlorinated hydrocarbon insecticides in houseflies. The logarithmic scale on the left indicates the median lethal concentration of various insecticides, which are shown as vertical lines. These, with the exception of DDT, are arranged in order of toxicity to the normal laboratory strain of flies (lab.). The irregular lines display the similar resistance 'pattern' of the following strains: U, Uruguay; O, Omdurman; S, Sardinia; and E, England

and β a *cis*-isomer; both are thought to be *endo* forms in respect of the isomerism about the 3*a*–7*a* carbon bond. Dieldrin and endrin (1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4*a*, 5, 6, 7, 8, 8*a*-octahydro-1 : 4, 5 : 8-dimethanonaphthalene); dieldrin is an *endo–exo*- isomer, whereas endrin is the *endo–endo*- form. Aldrin and isodrin (1, 2, 3, 4, 10, 10-hexachloro-1 : 4, 5 : 8-dimethano-1, 4, 4*a*, 5, 8, 8*a*-hexahydronaphthalene); aldrin is an *endo–exo*-isomer, whereas isodrin is the *endo–endo*- form. γ-BHC (γ-1, 2, 3, 4, 5, 6-hexachloro-cyclohexane).

These insecticides were dissolved in refined, high-boiling mineral oil (Shell risella oil), and their toxicities to the various fly strains determined by droplet applications, as in previous investigations[1]. The median lethal concentrations were estimated, the results being set out in Table 1 and illustrated by Fig. 1.

These results have certain interesting characteristics. It will be seen that the 'pattern' of resistance of the four fly strains is remarkably similar, despite their different histories and origin in such diverse geographical areas. All of them have developed highest resistance to α- and β-chlordane, dieldrin and aldrin. Resistance is intermediate to γ-BHC, and it is least developed against endrin and isodrin. Though three of the strains acquired resistance by the selective action of BHC used in the field, yet in all cases resistance to chlordane, dieldrin and aldrin is higher.

Possibility of a common defence mechanism. The results strongly suggest that the four strains depend on the same defence mechanism for dealing with insecticides of this type, though it may be more highly developed in some strains than others. From Fig. 1 it will be observed that the compounds aldrin and dieldrin, and the two isomers of chlordane, retain the same order of toxicity to the resistant as to the normal flies. In contrast, endrin, isodrin and γ-BHC, which are intermediate in toxicity to normal flies, are decidedly more toxic to resistant ones than the group mentioned above. This change is puzzling; but, indeed, the reasons for the original order of toxicity to normal flies is equally obscure. In a later paragraph it will be suggested that all these compounds have similar insecticidal action by reason of similar toxophores. If this is so, their individual levels of toxicity might depend on characters of the whole molecules, affecting such things as phase distribution or efficiency of absorption or diffusion. It is conceivable that these characters might have different effects at the high concentrations necessary for the resistant flies.

Another possible explanation could be offered if the resistance mechanism depended on detoxification; for this might well be more efficient with some compounds than others. Then, for example, one would expect dieldrin introduced into resistant flies to disappear faster than endrin.

The following tests were conducted. Batches of resistant females were injected with 0·1 per cent oil solutions of dieldrin or endrin. After various periods, the flies were ground up and extracted with ether and the insecticide remaining in the residue estimated

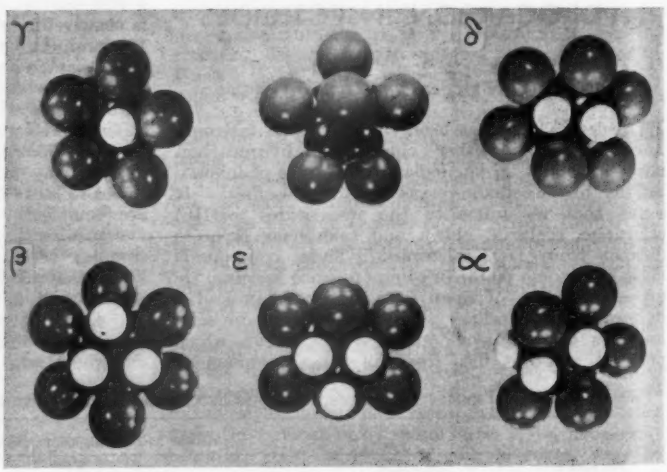

Fig. 2. Molecular models of *α*-, *β*-, *γ*-, *δ*- and *ε*-BHC and (top centre) end-view of a molecule of either chlordane, dieldrin, aldrin, isodrin or endrin, all of which have a somewhat similar pentagon. Key to the colours: black, carbon; white, hydrogen; grey, chlorine. It will be seen that for BHC the pentagonal arrangement of chlorine atoms occurs only in the *γ* form. (The bonding angles in the 5-membered carbon rings in these compounds are somewhat strained and the carbon balls have been slightly modified by Dr. S. L. Thomas to obtain a fit. In consequence, this model cannot be used for an accurate estimate of molecular dimensions.) The models were made by Messrs. Catalin, Ltd., according to specifications of Settatree, Thomas and Yardley (ref. 3)

Table 2. EXTRACTION OF DIELDRIN AND ENDRIN (μgm./fly): (*a*) FOR LIVING AND DEAD FLIES, RESPECTIVELY, AFTER 30 HR.; (*b*) LIVING AND DEAD FLIES TOGETHER, AFTER 0, 40 AND 70 HR.

	Living	Dead
(*a*) Dieldrin	0·21	0·24
Endrin	0·26	0·28

	0 hr.	40 hr.	70 hr.
(*b*) Dieldrin	0·26	0·24	0·19
Endrin	0·23	0·17	0·14

by bioassay, by wire-loop applications to susceptible male flies (Table 2).

These limited data suggest that the different degrees of resistance developed to these two compounds do not depend on relative ease of elimination.

Common factor of the γ-BHC–chlordane group. The second question mentioned earlier was the problem of the common factor of the γ-BHC–chlordane group of insecticides. The compounds chlordane, aldrin, dieldrin, endrin and isodrin have obvious similarity in part of their molecules; but γ-BHC appears quite different when represented graphically. When molecular models are prepared, however, it may be observed that five of the chlorine atoms of the chlordane group are arranged approximately symmetrically, with a sixth protruding from the centre. Models of the various isomers of hexachlorocyclohexane reveal a rather similar pentagon of chlorine atoms in the γ-form only (Fig. 2). It seems likely that this is the toxophore responsible for the high insecticidal activity of γ-BHC and the chlordane type insecticides. It may also explain the correlated resistance developed by flies to members of the group.

Additional evidence for this hypothesis was obtained by tests with a sample of octochloropropane, a highly chlorinated hydrocarbon not possessing a pentagonal arrangement of chlorine atoms. The median lethal concentration of this compound was found to be approximately 20 per cent for both the Omdurman and the laboratory strains. Thus, this substance is not highly insecticidal, nor does resistance to the γ-BHC–chlordane series alter the level of susceptibility to it.

Apart from chemical considerations, observations of the progress of intoxication in flies reveal similar features in γ-BHC and the chlordane group, which are quite different from signs of DDT poisoning. DDT causes continual, unco-ordinated movements; but until a late stage of intoxication, the wings can function normally. Flies poisoned by γ-BHC or by a member of the chlordane group frequently show 'fanning' movements of the wings, insufficient to cause flight. At a late stage of intoxication, the legs are all tightly contracted under the body and the wings are usually deflected downwards (cf. Weismann[4]).

It is interesting to learn that, in mammals, there is an analogous difference in signs of poisoning by DDT as compared with those due to the γ-BHC–chlordane group of insecticides. Dr. J. M. Barnes, of the Medical Research Council Toxicology Research Unit, kindly allows me to quote his observations, as follows: "When these insecticides are dissolved in 'Tween 80' (polyoxyethylene sorbitan oleate) and injected intravenously into rats, there are two types of effect. DDT and methoxychlor, like phenol, produce widespread muscular twitchings. The intensity of the tremors depends on the dose. In the case of DDT, convulsions are relatively minor in severity and come as a cumulation of the violent tremors. Death may not take place for 1–2 hours. With *gamma* BHC, aldrin, endrin, dieldrin and chlordane, fine muscular twitchings are not seen. The outstanding feature is convulsions, of sudden onset and extreme violence, often starting within a few minutes of giving a dose that is just lethal. Death may occur during convulsions, or after a period of unconsciousness following the convulsions. Death, if it occurs, usually takes place within 10–15 minutes".

[1] Busvine, J. R., *Nature*, **168**, 193 (1951).
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PHOTOLYSIS OF CHLORINE DIOXIDE AND ABSOLUTE RATES OF CHLORINE MONOXIDE REACTIONS

By F. J. LIFSCOMB, PROF. R. G. W. NORRISH, F.R.S., and DR. G. PORTER

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THE absorption spectrum of chlorine monoxide was first detected in the photochemical reaction between chlorine and oxygen[1,2] and all direct studies of its reactions have so far been carried out on this system. The mechanisms of these reactions have been thoroughly elucidated, but[3] it has been necessary to express the absolute rates and concentrations in terms of an unknown constant which is numerically equal to the extinction coefficient of chlorine monoxide at a given wave-length. The evaluation of this constant would lead to absolute extinction coefficients of chlorine monoxide at all wave-lengths, absolute concentrations under any required conditions and absolute rate constants of the reactions of chlorine monoxide.

The extinction coefficient appears in these quantities because the observed parameter is an optical density, D_λ, of the reaction mixture at a given wave-length λ. We then have

$$D_\lambda = \varepsilon_\lambda c l,$$

where ε_λ is the extinction coefficient of chlorine monoxide at this wave-length, c is its concentration and l is the length of the absorption path. It is therefore possible only to measure the product $\varepsilon_\lambda c$ and not the separate quantities. Since the relative extinctions at two wave-lengths are easily obtained, all can be referred to a standard extinction, ε_s, at a wave-length of 2577 A., which is in the continuous region of the spectrum and is therefore insensitive to the exact wave-length and independent of the resolving power of the spectrograph.

The ClO radical is removed by the bimolecular process:

$$2ClO = Cl_2 + O_2; \qquad (1)$$

and the rate constant of this reaction is given by

$$k_1 = 7{\cdot}2 \times 10^4 \times \varepsilon_s \exp \frac{(0 \pm 650)}{RT} \text{ litre mole}^{-1} \text{ sec.}^{-1}.$$

To evaluate ε_g, the concentration of chlorine monoxide must be known and, in principle, this can be found by difference if the concentrations of the other species present are known. Thus, in the reaction between chlorine and oxygen, the only species which contain chlorine and which are present in significant concentrations are chlorine monoxide and chlorine, and the decrease in concentration of chlorine should lead directly to the concentration of chlorine monoxide. Unfortunately, owing to the low extinction of chlorine, this decrease of concentration was below the limit of detectability and it was therefore only possible to give a lower limit for ε_g which was 310. Reasons were given for supposing that ε_g was less than 3,000, but no further limits could be fixed by these experiments.

The extinction coefficient of chlorine dioxide is much greater than that of chlorine and is of the same order of magnitude as the above predicted values for chlorine monoxide. It follows that, if chlorine monoxide were detected during the photolysis of chlorine dioxide, the decrease in concentration of chlorine dioxide should be readily measurable. We have therefore investigated this reaction by the same experimental methods as were used to study the chlorine–oxygen reaction. The photolysis flash was operated with an energy of 250 *J* and had an effective duration of 100 μsec. Pressures of chlorine dioxide were ½ mm. mercury or less, and the experiments were conducted in the presence of up to half an atmosphere of inert gas (argon, nitrogen or carbon dioxide) in order to reduce the rise in temperature to a few degrees. Plate densities were measured by reference to calibrations made with a neutral step wedge.

It was found that a single flash decomposed about 90 per cent of the chlorine dioxide and that this spectrum was replaced by that of chlorine monoxide, which then decayed slowly in the same manner as had been observed in previous work. Spectra of other chlorine oxides were absent at all times, and microphotometric measurements at 2780 A. established that chlorine trioxide (ClO_3), which has an extinction coefficient of 1,210 at this wave-length[4], could not have been formed in an amount greater than 1 per cent of the total chlorine dioxide decomposed. This is different from the photolysis of chlorine dioxide at normal intensities, where chlorine trioxide is a major product[5], but the difference can be understood in terms of the following competing reactions :

$$O + ClO_2 = ClO_3 \quad (2)$$

$$O + ClO = ClO_2 \quad (3)$$

$$O + O + M = O_2 + M \quad (4)$$

Since the ratio of the concentration of atomic oxygen plus chlorine monoxide to the dioxide is many thousand times greater in the flash experiments, the probability of reaction 2 relative to 3 and 4 will be correspondingly reduced.

The primary photolysis undoubtedly occurs by the process :

$$ClO_2 + h\nu = ClO + O ; \quad (5)$$

and therefore, if measurements are made before the chlorine monoxide has reacted to form chlorine, the concentration of chlorine monoxide will be given simply by the difference between the corresponding concentration of chlorine dioxide and the concentration originally present. Allowance was made for the chlorine monoxide which had reacted before measurement by carrying out a number of determinations at pressures of chlorine dioxide of 0·1, 0·2 and 0·5 mm. mercury, and extrapolating to zero concentration. The correction was very small, the observed value at the lowest chlorine dioxide pressure being only 4 per cent less than the extrapolated value, while the mean deviation from the mean at a given pressure was 7 per cent. The final value of the extinction coefficient at 2577 A. obtained in this way was 1,190 ± 100 litre mole^{-1} cm.$^{-1}$. Substituting this numerical value into the expression of Porter and Wright, we obtain :

$$k_1 (20° \text{ C.}) = 8·6 \times 10^7 \text{ litre mole}^{-1} \text{ sec.}^{-1}.$$

We have also measured the rate constant of removal of chlorine monoxide independently, using the same methods but preparing it by photolysis of chlorine dioxide. The mean value of the bimolecular constant obtained at 20° C. was $5·7 \times 10^7$ litre mole^{-1} sec.$^{-1}$. The difference between these two values is probably within the combined errors of the two completely independent determinations, which used different density standards for plate calibration. It follows that chlorine dioxide, like chlorine and oxygen, has no effect on the rate of disappearance of the ClO radical.

It has been pointed out that reaction 1 has a low frequency factor and the reasons for this have already been discussed[3]. It is one of the simplest bimolecular radical reactions for which quantitative rate data and spectroscopic constants are now available for more detailed theoretical treatment.

[June 15.

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[4] Goodeve, C. F., and Richardson, F. D., *Trans. Farad. Soc.*, **33**, 453 (1937).
[5] Bodenstein, Harteck and Padelt, *Z. anorg. allgem. Chem.*, **147**, 233 (1925).

RESTRICTION OF INFLAMMATORY RESPONSE BY POLYSACCHARIDES

By M. SHILO, B. WOLMAN and SHLOMO HESTRIN

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THE suggestion that colloids from the blood plasma may coat the capillary endothelium and that the porosity of the latter may thereby be reduced was advanced more than a decade ago[1]. However, the possibility of utilizing this mechanism as a means of restricting inflammatory response has perhaps not been appreciated clearly. Water-soluble polysaccharides frequently occur on micro-organisms in the form of capsular envelopes. It is relevant to the mechanism of infection and of interest to learn whether such polymers also can act on blood vessels as wall-coating agents. In the experiments described here, we have attempted in particular to ascertain whether neutral and high-molecular bacterial polysaccharides, lævan and dextran, systemically administered, retard escape of blood colloids and cells across the capillary wall at sites of tissue injury.

The influence of the intravenous administration of high-molecular polysaccharide on the capacity for

acute inflammatory responses to local irritants is illustrated by the results in Table 1. The saccharide used was native lævan of *Aerobacter levanicum* (3 per cent in saline), given intravascularly before the irritant in doses of 100 mgm./kgm. in rabbits and guinea pigs, and of 500 mgm./kgm. in mice. This preparation, though apparently non-toxic towards the mice and guinea pigs, evoked an untoward reaction (immediate diarrhœa and occasionally death) in a few rabbits. The irritants were: (1) peptone, 0·1 ml. of 10 per cent 'Difco' proteose peptone in saline; (2) turpentine, 0·005 ml.; (3) staphylococcus, 0·1 ml. of a suspension of a *Staphylococcus* sp. grown on an agar slant for 24 hr., washed and finally suspended in 5 ml. of saline. These findings show that inflammation throughout an area of injury can be markedly restricted or prevented both by a lævan and a dextran. The same effect was uniformly present in systems involving different irritants, tissues and hosts.

Table 1. Influence of High-polymer Lævan on Acute Inflammatory Responses

Irritant	Route of irritant	Animal	Reactions: no lævan	Reactions: lævan
Peptone	Intradermal	Rabbit	+ (*a*)	—
Turpentine	Intradermal	Rabbit	+ (*a*, *b*)	—
Staphylococcus	Intradermal	Rabbit	+ (*a*, *b*, *c*, *d*)	—•
Staphylococcus	Intradermal	Guinea pig	+ (*b*, *c*)	—•
Staphylococcus	Intra-peritoneal	Mouse	+ (*e*, *f*)	—

• When the high-polymer dextran of *Leuconostoc mesenteroides* was used instead of lævan, the same gross result was obtained.
+ indicates the presence of the inflammatory responses listed in parentheses; — their absence or marked diminution.
a = local blueing reaction within 1 hr. when 5 ml. of 1 per cent trypan blue in saline was administered intravenously immediately before irritant;
b = local œdema at 4 hr.;
c = local erythema at 4 hr.;
d = diapedesis at 1 hr. as observed in histological preparations;
e = markedly increased number of leucocytes in peritoneal exudate at 4 hr.;
f = marked elevation of the amount of an agglutinin (*Salmonella typhi O* 901 rabbit antiserum) in the peritoneal exudate 4 hr. after the intravenous administration of the agglutinin.

A *Staphylococcus* sp. injected intradermally into normal guinea pigs and rabbits evoked skin lesions which were soon localized and became purulent within a day. In hosts with diminished inflammatory responsiveness, such skin lesions are known to be non-purulent and to show a tendency to spread[2]. When rabbits or guinea pigs received lævan or dextran systemically, the intradermal inoculation of the staphylococcus regularly evoked a spreading and necrotic rather than a purulent lesion (see Fig. 1). These findings have strongly supported the concept that the promoting effect of lævan and dextran on infection is mediated by the ability of the polysaccharides to arrest inflammatory responses[3].

Dr. E. Margoliash in this laboratory has also found that subcutaneous resorption of a foreign tissue (fragments of a transplantable mouse mammary carcinoma) in the rat can be greatly retarded by daily intraperitoneal injection of lævan: the resorption in the normal rats was advanced in four to five days; resorption was less marked after two weeks in the 'lævanized' animals. Thus it appears that the lævan can inhibit a presumably chronic process of inflammation and not only the acute inflammatory responses.

The question arises whether the polysaccharides prevent or simply mask the capillary injury. We observed that 1–3 hr. old skin lesions produced in rabbits by intradermal injection of turpentine show

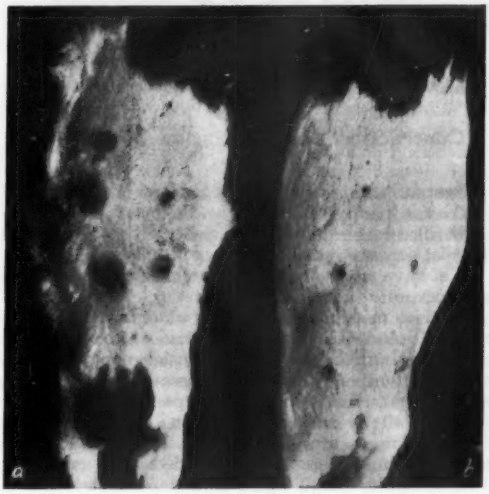

Fig. 1. Influence of high-polymer lævan on a cutaneous staphylococcus infection: guinea pigs infected intradermally at several dorsal sites. The inoculum was 0·1 ml. of suspension of washed cells of a *Staphylococcus* sp., the doses corresponding respectively in the lesions of the left and right rows to 1/50 and 1/500 of an agar slant. Lævan (150 mgm.) was administered intravenously. Photographs show lesions after six days. Lesions are purulent and localized in the non-lævanized control (*b*), whereas they are non-purulent, characteristically necrotic, and cover a relatively large skin area in the lævanized animal (*a*)

an almost instantaneous blueing reaction with intravenously injected trypan blue. When rabbits with the preformed skin lesions received lævan 30 min. before the injection of the dye, the blueing reaction at the injured sites was prevented or greatly diminished and delayed. This suggests that lævan effects the rapid masking of the capillary injury.

Both the ability to restrict inflammatory response and the attendant ability to promote infection are manifested by some shocking agents[2] and by cortisone[4] as well as by the polysaccharides. However, the mechanisms whereby these classes of substances affect the inflammatory response could, of course, be quite distinct. The activity of the polysaccharides was diminished greatly or abolished when molecular weight was reduced from greater than 10^6 to 10^4–10^5, which is the range acceptable in a plasma expander. Hence the activity is not determined solely by the structure of the polymer repeating-unit. The activity, however, could well be simply a function of capacity, dependent on molecular size, for adsorptive combination and resulting formation of an extraneous polysaccharide coat on the surface of the endothelium (cf. ref. 5).

A detailed report and discussion of clinical implications will be presented later. We thank Dr. M. Wolman for criticism and the analysis of histological preparations. Support of the investigation by a grant from the Scientific Department, Defence Ministry of the Government of Israel, is gratefully acknowledged. [May 5.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Contraction and Relaxation of Collagen Fibres

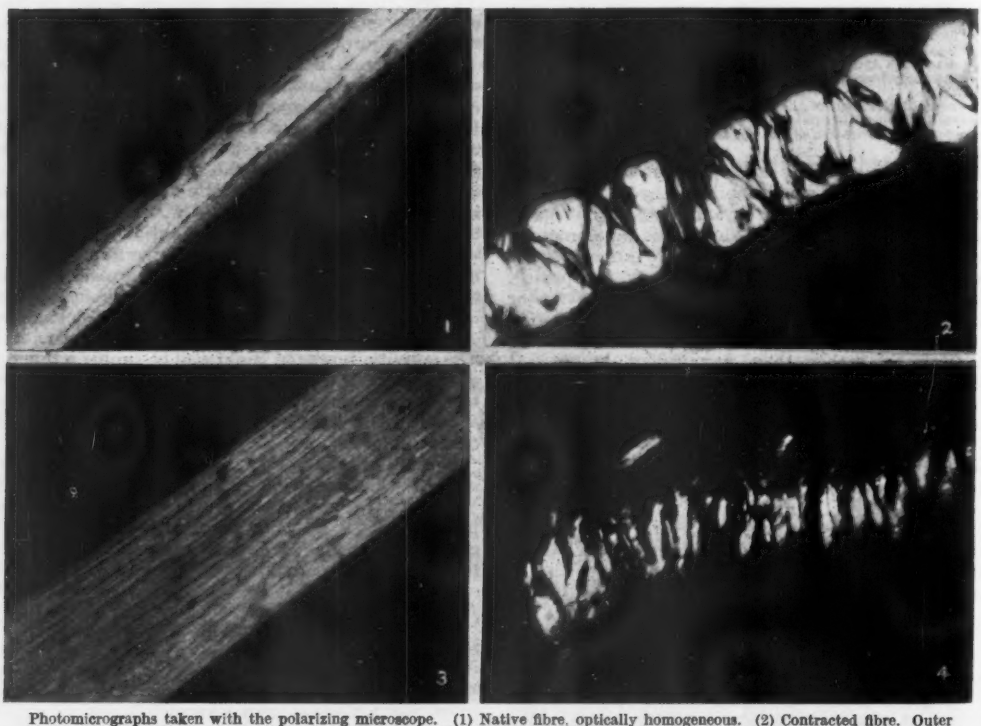
Partridge[1] reported that tendons from the tail of the rat loaded with small lead shot at above 60° C. in distilled water first shorten and thereafter lengthen, that is, contract and relax.

We have studied this phenomenon in detail by polarization microscopy, and by chemical and enzymical methods using isolated collagen fibres of rat tail tendon. We found that contraction and relaxation can be brought about also without heat at room temperature in concentrated salt solutions such as potassium iodate and potassium mercury-iodate in 40 per cent concentration. Single dry native fibres 1–2 mgm. in weight, 0·10–0·20 mm. in diameter and 5–6 cm. in length were loaded with small lead shot weighing 70–80 mgm. and placed at room temperature (20° C.) in the solutions mentioned above. Contraction starts after 20–30 sec. and ceases in 1–2 min. The fibres shorten to one-third of their length (67 per cent shortening). The relaxation only begins after 20–25 min., and it stops after approximately 60 min., when the fibres have lengthened to 80–85 per cent of their original length. We call this phenomenon observed in concentrated salt solutions at room temperature 'chemical contraction and relaxation'.

We have established that by the heat contraction of collagen fibres performed in water at 67° C. the fibres (as above) contract in 7–10 sec. and relax in 40–60 sec. The shortening is the same as in 40 per cent potassium iodate (67 per cent); the relaxation is 100 per cent. The analyses made by polarization microscopy and with chemical and enzymic methods show that the heat and chemical contraction – relaxation processes are similar to each other.

The native, contracted and relaxed fibres were examined separately in the wet and the dry state. The contracted fibres when wet are elastic, rubber-like, in contrast to the non-expansible native and easily torn relaxed fibres. By polarization microscopy we found that whereas the native fibre is optically homogeneous, in the contracted fibre two optically different phases can be observed: apparently an outer phase with small birefringence and an inner phase with helical structure and strong birefringence. The relaxed fibre is again homogeneous, showing fibrillary structure (Figs. 1, 2 and 3). Imbibition experiments show that in contracted fibre the two phases differ both qualitatively and quantitatively from each other.

The dissolution of protein was examined during the contraction – relaxation processes with larger amounts of collagen fibre. While the fibre is passing from the native to the contracted state, only a small quantity of mucoid[2] is dissolved; but the beginning of relaxation is connected with the dissolution of a larger amount of protein. Having kept the fibres for 20 min. in 40 per cent potassium iodate, relaxation starts; thus 36 per cent of the nitrogen of



Photomicrographs taken with the polarizing microscope. (1) Native fibre, optically homogeneous. (2) Contracted fibre. Outer phase of small birefringence and internal phase of strong birefringence with helical structure. (3) Relaxed fibre, swollen, with pronounced fibrillary structure. (4) Contracted fibre after the effect of elastase; the outer phase is dissolved. × 100

the collagen is dissolved, and in 60 min. (complete relaxation) 75 per cent of the nitrogen of collagen goes into solution. By heat relaxation the same dissolution of protein takes place. At 67° C. in 2 min. 14 per cent, in 5 min. 47 per cent and in 10 min. 73 per cent of the nitrogen of the collagen is dissolved. The gross structure of the collagen fibre remains, as if the protein has dissolved only from the inside.

With elastase at *p*H 10, only 5–10 per cent of the native fibres were dissolved. From the contracted fibre the elastase dissolves the outer phase, which accounts for 15–20 per cent of the entire collagen nitrogen, while the internal phase remains intact. Fig. 4 shows a contracted fibre after treatment with elastase. The relaxed fibres are dissolved with elastase without residue.

The contraction process remains reversible if the fibres, just after contraction, were removed from the solution, washed, stretched and dried in the stretched state. But after relaxation, contraction could no longer be observed.

In a previous experiment, one of us (Banga[2]) showed that during the heat contraction of Achilles tendon a mucoid is dissolved which contains 6–8 per cent of carbohydrate. In those experiments the relaxation is already beginning and the analytical results may have related to the combination of two substances. It is to be noted that in Achilles tendon of cattle the heat contraction – relaxation processes follow much more slowly than in the collagen fibre of rat tail tendon.

Our experiments seem to prove that the collagen fibre is not built up from a single protein but at least of two different protein components. In our experiments the chondroitin sulphuric acid content of the ground-substance which stabilizes the collagen fibre does not play a part in the process of contraction – relaxation. This is shown by the following experiment. We treated the native collagen fibres with a concentrated aqueous solution of hyaluronidase, which dissolves chondroitin sulphuric acid. After treatment for 24 hr., contraction and relaxation took place in the usual way. This indicates that neither of the two proteins described corresponds to chondromucoid.

A paper containing the detailed results of the experiments will be published in the *Acta Morph. Acad. Sci. Hung.*

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A Lipid Component of Reticulin

In a previous communication in *Nature*[1], renal cortical reticulin was described as consisting of randomly orientated collagen fibrils embedded in a structureless matrix. X-ray diffraction photographs of these reticulin specimens showed a diffraction pattern quite typical of that of collagen, together with some additional rings; this suggested that the reticulin consisted of collagen together with an unidentified material.

Further studies on the chemical composition of this reticulin, isolated from kidneys as before, indicated that a fat component was present.

The X-ray diffraction pattern of this isolated fat has been compared with that of a series of saturated fatty acids, and the spacings and intensities show close agreement with the series. The precise member of the series present in reticulin was not identified from the diffraction pattern alone, but a melting point over the range 49°–52° C. suggested a mixture of fatty acids, with myristic acid predominating. Analysis by Imperial Chemical Industries, Ltd., using vapour phase chromatography, has given more than 90 per cent myristic acid.

In the X-ray diffraction pattern of reticulin, the broad collagen band at 4·5 A. somewhat masks the bands seen at 4·5 and 3·8 A., which are very intense when the isolated lipid component is examined alone. Outside the classical 2·9 A. collagen band seen in reticulin are other rings at 2·5, 2·35 and 2·2 A.; and these outer rings correspond very closely with those seen with saturated fatty acids.

From a reassessment of the electron microscope results, it is probable that the lipid was present in those regions which were too thick to give clear photographs. The reticulin as isolated was therefore a mixture of three components—collagen, fatty acid and polysaccharide-containing matrix. From the extraction methods used for isolating the reticulin samples, it was clear that the fatty acid was an essential component of the reticulin, and not a contaminant from extra-reticular sources.

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Staining Reactions of Elastic Fibres with Special Reference to 'Elastotic Degenerations' in the Human Skin

Part of our research programme is devoted to clarifying various aspects of skin carcinoma in man and in experimental animals. Careful study of the dermal accumulations of morphologically unusual fibrillar material, consistently found in our specimens, and generally referred to by other authors[1] as "an increase in elastic fibres", led us to suspect that these accumulations of unusual fibrils were not, in fact, unmodified elastic fibres. We conducted a systematic survey of the staining reactions of the fibrillar masses in the dermis and in diseased blood vessels, always carefully comparing our findings in the abnormal with those of the elastic and other fibres in apparently healthy human skin, aorta and other vessels.

The unusual clumps of dermal fibres, referred to above, as well as certain fibres which may appear in vessel walls during degenerative vascular diseases, stain with some of the dyes (for example, Weigert's, Verhoeff's, orcein and Gomori's aldehyde-fuchsin, in particular), but not with all the stains which sharply delineate apparently 'normal' elastic fibres. On the other hand, these same fibre clumps may stain with several dyes, or dye-mixtures, which do not stain 'normal' elastic fibres (see Table 1).

The conclusion, therefore, seems to be justified that the accumulations or clumps of morphologically

Table 1. Tinctorial Reactions of Elastic Fibres in Healthy Dermis and Arteries compared with 'Elastotically Degenerated' Fibres

Stain	'Normal' elastic fibres—dermis or arteries	'Elastotically degenerated' fibres—dermis or arteries
Orcein	Deep red-brown	Pale to deep reddish-brown
Verhoeff's	Dark blue-black	Pale to dark blue-black
Weigert's	Deep purple-blue	Deep purple-blue (+ eosinophilic 'granules')
Gomori's aldehyde-fuchsin	Deep red-purple	Deep red-purple to pale red
Periodic acid-Schiff	Red borders	Irregular red 'pools' and pink fibre borders
Iron hæmatoxylin	Grey, black or brown	Grey to jet-black fibres, rods and 'pools'
Safranin water-blue (Unna)	Pink to red	Pink to deep red
Van Gieson	Yellow with thin red fibre outlines	Yellow with irregular red 'granules'
Wilder's reticulum and basic fuchsin	Red fibre 'cores' with thin black outlines	Irregular coarse granular and fine black fibres
*Ponceau 2R—light green	Bright pink-red	Irregular blotchy 'grey' with red and yellow patches
*H. and E.	Pale pink	Pale blue-grey + pink 'granules' and threads
*Toluidine blue	Colourless to pale-blue	Deep blue-green coarse fibres and 'granules'
*Mallory's triple	Orange to pink	Completely chromophobic with scattered orange or blue 'granules'
*Mallory's phosphotungstic acid hæmatoxylin	Bright purple 'coat' with orange 'core'	Pale orange with occasional purple threads
*Rinehart–Abul Haj†	Pale yellow 'cores' with bluish-green outlines	Dirty pale green with scattered blue 'pools'

* Implies stains providing clearly distinguishable tinctorial differences between 'true' elastic fibres and 'elastotically degenerated' fibrillar aggregations.

† Modified Hale's method for acid mucopolysaccharides (ref. 4).

abnormal fibres, particularly in the dermis, while simulating that "increase in elastic fibres" described by modern authors, cannot be regarded as being constituted of unaltered elastic fibres, either on morphological or on tinctorial criteria. We suggest the name 'elastotically degenerated' fibres for these masses, since they are morphologically and tinctorially distinguishable from normal elastic and collagen fibres, although they stain with the generally used elastic stains.

These elastotically degenerated fibres seem to be derived primarily from alterations in the composition of preformed collagen, or, perhaps, from disturbances in metabolic processes during the formation of normal reticular, collagen or elastic fibres. The former possibility, concerning the origin of 'elastotically degenerated' fibres, is supported by our recently recorded finding[3] that, some time after the grafting of trypsin-treated auto- or homo-dermal tissue in man, numerous plaques or even extensive beds of 'elastotically degenerated' tissue can usually be found in the dermis of the host area. These fibre masses may have been derived from the original collagen of the graft. Alternatively, the grafted dermal collagen may have induced a change in the metabolism of the connective tissue in the host site, resulting in the deposition of new fibres, which were 'elastotically degenerated' *ab initio*—a possibility in conformity with the latter of the above two suggestions. Stages in the formation of these abnormal fibres, in dermis, can be defined on the basis of tinctorial reactions with the aid of the above-mentioned dyes. The final product of such elastotically degenerated fibres can be sharply distinguished from an increase in 'true' elastic fibres and from 'normal' collagen fibres.

Our findings also indicate that the generally accredited standard histological methods for demonstrating elastic fibres cannot be relied on to stain only 'normal' elastic fibres. This latter view is in conformity with that expressed by Astbury *et al.*[3] from their combined histological and electron-microscopic studies of normal and abnormal human dermis.

The expenses incurred during this study were defrayed primarily by a generous grant from the Schlesinger Organization, South Africa. Literature was made available, in part, through the Florence Powell Cancer Research Library Grant and through the kind assistance of Mrs. B. H. Robinow. We also acknowledge the technical assistance of Patricia R. Low.

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Secretion of Aldosterone and Corticosterone by the Rat Adrenal

A study has been made of the nature and regulation of rat adrenal steroid secretion. The adrenal-vein blood of rats was collected, extracted and chromatographed by the method of Bush[1,2]. Corticosterone was detected and estimated by the soda-fluorescence reaction[1]. Mineralocorticoid activity was estimated by the biological method of Simpson and Tait[3].

A potent mineralocorticoid was detected in the zone of the paper chromatogram which would include aldosterone[4,5]. In concentrates of this zone there was a substance which had the same R_P and soda-fluorescence reaction as aldosterone and was present in an amount appropriate to the observed biological activity. The activity of this zone has been tentatively identified with aldosterone.

Intact rats, subjected to the surgical stress of collection of adrenal effluent, secreted aldosterone equivalent to about 45 μgm. of deoxycorticosterone acetate, and 150 μgm. corticosterone per adrenal/kgm./hr., with a ratio of 0·30 : 1. Treatment with deoxycorticosterone acetate for seven days (2 mgm. per day), or feeding a potassium-deficient diet for four weeks, reduced the secretion of aldosterone by more than 90 per cent without altering the corticosterone secretion. The ratio was lowered to 0·014 : 1 by the potassium-deficient diet, and to 0·044 : 1 by the deoxycorticosterone acetate treatment.

Untreated hypophysectomized rats, examined at two, seven or fourteen days after operation, secreted an average of 7·8 μgm. deoxycorticosterone acetate equivalent of aldosterone and 2 μgm. of corticosterone, per adrenal/kgm./hr., with a ratio of 3·65 : 1. In hypophysectomized rats two days after operation, acute treatment with corticotropin (homogeneous by

ion-exchange chromatography[6]; 1 μgm. at the start, and 0·5 μgm. during collection) raised the rates of secretion of both steroids. There was a greater proportional increase in the corticosterone, and the quantities of both steroids secreted were not significantly different from those in intact rats. A similar result was obtained when hypophysectomized rats received a daily dose of 200 μgm. corticotropin for seven or fourteen days after operation, and the adrenal effluent was then collected with acute corticotropin stimulation.

Hypophysectomized rats kept for seven days without corticotropin maintenance gave a different response to acute treatment with corticotropin. The aldosterone secretion was increased to the equivalent of 50 μgm. of deoxycorticosterone acetate, comparable with the values in intact rats, but the corticosterone only to 9 μgm. per adrenal/kgm./hr. The ratio of the secretions, 5·4 : 1, remained typical of untreated, hypophysectomized rats.

In the only experiment on this point, daily treatment of hypophysectomized rats with both deoxycorticosterone acetate and corticotropin depressed aldosterone secretion to a level similar to that of the intact rats treated with the former, without influencing the secretion of corticosterone. This experiment suggests that changes in the secretion of aldosterone following treatment with deoxycorticosterone acetate, and possibly those following changes in electrolyte balance, can occur in the absence of the pituitary.

These studies show that a potent mineralocorticoid, probably aldosterone, is secreted by the rat adrenal; this observation is analogous to those of Simpson *et al.* with the dog and the monkey[7]. The results provide direct support for the indirectly based view of Swann[8] and later workers[9], according to which mineralocorticoid secretion in the rat can vary independently of glucocorticoid secretion and can be influenced by extra-pituitary factors. However, our experiments show clearly that the simultaneous secretion of both aldosterone and corticosterone can be induced by corticotropin. It is also noteworthy that secretion of both steroids still occurs in the hypophysectomized rat without corticotropin.

We wish to point out that these results do not provide any evidence relating to the proposition that the zona glomerulosa of the rat is specifically associated with secretion of aldosterone.

A detailed account of these studies will be presented elsewhere. This work was largely financed by a grant from the Nuffield Foundation to Prof. F. G. Young and was under his general direction.

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Development of Pain-producing Substance in Human Plasma

WE have previously reported[1-3] that inflammatory exudates and fresh plasma produce: (i) pain when applied to the exposed base of a cantharidin blister in man, and (ii) contraction of the isolated rat uterus. Since we find these two actions to run in parallel, we assume that they are due to the same agent, which we term 'pain-producing substance'. When an inflammatory exudate is collected in a glass syringe, this substance is not at first detectable, but develops within 2–5 min. The same is true of whole blood, with or without anticoagulant.

The development of pain-producing substance in plasma can be prevented by avoiding contact with glass or metal during the process of collection and separation, as follows. Blood is withdrawn into a silicone-coated needle and syringe and rapidly transferred through polythene tubing immersed in ice to cooled polythene centrifuge tubes containing heparin (40 units/ml., final concentration). The blood is immediately centrifuged at 22,000 rev./min. for 4 min., after which the upper half of the separated plasma is removed and placed in fresh polythene tubes in ice. This plasma, in which there are no white cells and practically no platelets (< 50/c.mm.), contains little or no detectable quantity of the pain-producing substance when kept in polythene tubes for up to two hours, but activity develops within a few minutes after the plasma is transferred to a glass tube. This activity reaches a peak within 10 min. and decays to 1/10–1/20 of peak value within an hour. The decay of the substance in plasma is delayed at 0° C. and prevented by deep-freezing.

The same effects are observed when sodium citrate (3 mgm./ml., final concentration) is used as anticoagulant. In the absence of anticoagulant, plasma kept in polythene tubes still fails to develop the pain-producing substance; but when it is transferred to glass tubes activity appears and clotting occurs.

Biological actions of the pain-producing substance. (i) Active plasma applied to an exposed blister base produces delayed and prolonged pain[1]. It does not cause itching, flare or wheal. Our previous report[1] that plasma did not produce pain referred to tests performed from one to three hours after collection of blood, when the pain-producing substance would have decayed.

(ii) It causes contraction of the isolated rat uterus. At peak activity, 0·01 ml. of plasma (in a 30-ml. bath) may produce maximal uterine contraction. This action is not antagonized by atropine or dihydroergotamine. This preparation is particularly suitable for routine assays of the pain-producing substance.

(iii) It produces delayed slow contraction of the guinea pig ileum and also stimulates the rabbit jejunum. It lowers blood pressure in the cat and rat.

Chemical properties of the pain-producing substance. (i) Pressure ultrafiltration at 0° C. of active plasma through a 'Cellophane' membrane yields protein-free filtrates containing the pain-producing substance; their activity rarely exceeds one-fifth of average peak activity in plasma. Pain-producing substance produced in this way is stable for several hours at 20° C. There are, however, certain minor differences between the biological actions of ultrafiltrates and their parent plasmas, perhaps due to the presence of modifying substances in the latter.

(ii) Freeze-dried samples of active plasma or ultrafiltrate are active; such material can be used to study solubility characteristics of the substance.

(iii) The substance is soluble in water, glacial acetic acid, hot methyl alcohol, 90 per cent ethyl alcohol and 90 per cent acetone. It is insoluble in ether, absolute ethyl alcohol and anhydrous acetone.

(iv) It is precipitated with the proteins when alcohol or acetone (10 or 20 vol.) is added to active plasma in the cold.

(v) It is adsorbed by charcoal and cellulose powder, but not by barium sulphate. It is completely removed from ultrafiltrates by cation exchangers (hydrogen form), and partially removed by anion exchangers (hydroxyl form).

(vi) Pain-producing substance from ultrafiltrates is stable on boiling in $N/3$ hydrochloric acid for 10 min., but is largely destroyed on boiling in $N/3$ sodium hydroxide for 10 min.

(vii) It is rapidly inactivated by plasma.

(viii) The substance is inactivated by chymotrypsin (Armour). Trypsin (Armour) has a much weaker action, and crystalline pepsin has no effect.

It has not yet been possible to isolate the pain-producing substance in a pure form. Its biological and chemical properties resemble those of bradykinin, a polypeptide prepared by Rocha e Silva *et al.*[4,5] by the action of trypsin or *Bothrops jararaca* venom on plasma α-globulins.

A sample of bradykinin (activity 10 units/mgm.) in a concentration of 10 μgm./ml. produced pain like that due to our pain-producing substance; 100 μgm./ml. also produced itching, flare and wheal. Bradykinin also stimulates smooth muscle and lowers blood pressure[4]. It is rapidly inactivated by plasma and by chymotrypsin, but not by trypsin[6]. On Rocha e Silva's estimate[5] that such bradykinin preparations contain about 0·5 per cent of a pure polypeptide of molecular weight 5,000–10,000, our most active plasmas contain pain-producing substance in a concentration equivalent to 1 μgm./ml. of the pure bradykinin.

Certain other biologically active polypeptides, for example, angiotonin (hypertensin), substance *P*, leucotaxine, oxytocin and vasopressin, also produce both cutaneous pain and contraction of smooth muscle; but studies on relative potency, and some differences of action, have shown that our pain-producing substance is not identical with any of these. Nevertheless, the evidence suggests that it is a polypeptide. It can be readily distinguished from 5-hydroxytryptamine (serotonin)[2,3].

The processes concerned with the appearance of the pain-producing substance in cell-free plasma are obscure, but the failure to develop activity in contact with polythene and the time-course of development in contact with glass are strikingly reminiscent of the processes of blood clotting. However, heparin and sodium citrate do not prevent the activation of plasma by glass. The rapid decay of the substance in plasma, coupled with its much greater stability in protein-free solutions, suggest an enzyme-catalysed destruction.

The role of the pain-producing substance in the production of pathological pain is being studied. We suggest that development of the substance might occur when plasma escapes from capillaries and makes contact with damaged tissues as, for example, in burns.

We are grateful to Dr. M. Rocha e Silva and to Dr. H. O. Schild for bradykinin; to Dr. A. C. Corcoran and Dr. F. Merlin Bumpus for lyophilized angiotonin; to Dr. B. Pernow for substance *P*; to Dr. W. G. Spector for leucotaxine; and to Prof. C. J. O. R. Morris for the loan of the ultrafiltration apparatus. We should like to thank Mr. B. J. Stevens for valuable technical assistance.

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Estimation of the Survival-Rate of Anopheline Mosquitoes in Nature

The daily survival-rates of *Anopheles gambiae* and *A. funestus* in two areas of tropical Africa have recently been estimated from the ratio of their sporozoite-rates immediately on capture and those recorded after keeping wild-caught specimens alive for the duration of the extrinsic cycle of the predominant malaria parasite[1,2]. This method naturally involves considerable time for the dissection and keeping alive of significant numbers of mosquitoes.

A more direct method of determining the age-composition of wild-caught populations, based on changes in the size of the ampulla of the oviduct with ovarian development and oviposition[3], has now been evolved. By this method the proportion of a given population which is parous (M) can be determined and the survival-rate per day (p) calculated from the expression[4], $p^n = M$, where n is the number of days between emergence of adult and first oviposition.

Table 1. Ampulla Diameters of Colony *A. gambiae* measured in Distilled Water

Stomach and ovary conditions	No. of mosquitoes examined	Ampulla diameters in microns: Mean	Standard error	Median
Nulliparous females				
Never fed—ovary stage I	145	124	1·8	120
Fed once, but no ovarian development beyond stage II	187	168	2·2	160
Fed once or twice with ovarian development to stage III	72	204	3·1	200
Fed once or twice and gravid—ovary stage V	85	242	3·2	240
Parous females				
Laid once after one or two feeds—ovary stage II	62	265	3·8	264
Laid once, fed again and developing the second batch of eggs—ovary stage III	44	258	4·3	256
Laid twice—ovary stage II	25	279	4·7	280

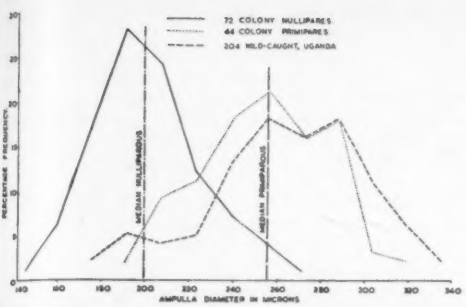

Fig. 1. Frequency distribution of ampulla diameters of colony and wild-caught *A. gambiae* with stage III ovaries

Evidence now exists[1,5] that in the case of *A. gambiae* the time from emergence to first oviposition is five days in the hotter parts of Africa, composed of: (*a*) the first feed, 24 hr. after emergence, but without ovarian development beyond ovary stage II; (*b*) the second feed, two days after the first; (*c*) two days elapsing from the second feed to the maturation of the eggs and oviposition.

Extensive studies of colony *A. gambiae* have shown increases in diameter of the ampulla of the oviduct with feeding, ovarian development and oviposition (Table 1); these were most marked when dissection was carried out in distilled water. At the same time, considerable variation in ampulla diameter was found to occur in females in the same stage of ovarian development in the same gonotrophic cycle and, as a result, a considerable overlap in measurements between mosquitoes in the same stage of ovarian development but in successive gonotrophic cycles (Fig. 1). However, the smallest diameter recorded for a particular ovary stage in primiparous females was very seldom less than the median diameter recorded in nulliparous females in the same stage. Thus it is considered justifiable, when dealing with wild-caught mosquitoes of any one ovary stage, to take those showing ampullæ of less diameter than the median recorded in nulliparous females of the same ovary stage as half the nulliparous females.

The proportions parous in each of the ovary stages II–V (females with stage I ovaries were obviously nulliparous) have been estimated in this way in three series of wild-caught *A. gambiae* from the two areas of Africa where the immediate and delayed sporozoite-rates were estimated (two of the series were dissected over the same periods as the latter), and the survival-rates were found to be almost identical by the two different methods (Table 2).

In practice it is considered simpler, instead of dissecting mosquitoes in all ovary stages, to restrict dissections to those of the commonest ovary stage found in Nature by the usual methods of mosquito capture. In the hotter parts of Africa the commonest ovarian stage in daytime house-resting *A. gambiae* is stage III. In this species the first stage III ovary is normally reached on the fourth day after emergence,

Table 2

Locality	Survival-rates: From immediate and delayed sporozoite-rates	From ampulla measurements
Tanganyika, 1952	0·93	0·94
Tanganyika, 1953	—	0·90
Uganda	0·97	0·95

and the gonotrophic cycle at temperatures of 23·3° C. and higher is two days[6]. Thus the proportion of mosquitoes at this ovarian stage which is nulliparous is:

$$\frac{p^4}{p^4 + p^6 + p^8 + p^{10} \ldots p^\infty} = p^4 \Big/ \frac{p^4}{1 - p^2} = 1 - p^2;$$

from which p^2 = 1 − proportion nulliparous = proportion parous.

Therefore, $p = \sqrt{\text{proportion parous.}}$

Thus the survival-rate equals the square root of the proportion parous if the gonotrophic cycle occupies two days (the cube root if it occupies three days).

In the three series of wild-caught *A. gambiae* already mentioned, the survival-rates calculated from stage III females only were:

Tanganyika, 1952	0·91
Tanganyika, 1953	0·91
Uganda	0·93

Thus the method in its simplest form requires:

(1) Analysis on colony-bred mosquitoes of the median ampulla measurement, and its range, for nulliparous and parous mosquitoes in the same stage of ovarian development (preferably stage III); this has been done for *A. gambiae*.

(2) A knowledge of the period occupied by the gonotrophic cycle.

(3) Capture of wild mosquitoes and derivation by the method given of the proportions nulliparous and parous; it is thought that this can be estimated with considerable accuracy providing it is established that none, or very few, of the ampulla diameters of parous mosquitoes fall below the median of nulliparous ones.

(4) Derivation from this of the daily survival-rate; this depends on an assumption that the population is relatively static in composition and needs correction by observation over several consecutive days.

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Influence of Ribonuclease on the Division of Amphibian Eggs

Thomas, Rostand and Grégoire[1] observed that the puncture with a needle which had been dipped in a relatively pure solution of ribonuclease inhibits the development of undivided frog's eggs and prevents cellular division. They also showed that no such effect is obtained with deoxyribonuclease, nor with pepsin or trypsin used under the same conditions. We thought it of interest to repeat these observations with highly purified enzymatic preparations, taking advantage of the fact that only reduced ribonuclease has enzymatic activity[2].

Fertilized amphibian eggs (*Rana fusca*, *Axolotl*, *Pleurodeles*) were injected with reduced or oxidized ribonuclease; urease was used as a control. Reduced ribonuclease was prepared as previously described[2]; oxidized ribonuclease was prepared by the action of hydrogen peroxide on the reduced form[3].

Of all enzymes tried, only reduced ribonuclease was active; division of the injected blastomere was inhibited with concentrations of the order of 10^{-18} mol. per egg. Using higher concentrations, the neighbouring blastomeres are also affected. Neither oxidized ribonuclease nor urease (—SH form) showed visible effects, even when 10^8 times more concentrated. Thus, only the enzymatically active reduced form of ribonuclease inhibits embryonic development, and the conditions of preparation of the enzymes exclude all possibility of contamination.

These results confirm those of Thomas, Rostand and Grégoire, and emphasize the need for the —SH groups in the enzyme. As the injection of concentrations higher than 10^{-18} mol. in one of the blastomeres of segmenting embryos inhibits the development of the neighbouring blastomeres, we thought this might be an indication that the enzyme is capable of crossing cellular membranes. We therefore placed the eggs of pleurodeles in solutions of reduced and oxidized ribonuclease of different concentrations. In these conditions, embryonic development is completely stopped by concentrations of reduced enzyme greater than or equal to 100 μgm./ml. Oxidized ribonuclease is also completely without effect on segmentation (Figs. 1, 2 and 3).

In order to verify if the enzyme really penetrates into the egg, we prepared radioactive oxidized and reduced ribonuclease with radioactive iodine[4] and we followed its diffusion by radioautography[5]. Sections show a zone where radioactivity appears in the embryo and which extends progressively from the animal pole. Simultaneously a zone of increased basophily appears in the radioactive region, but only when reduced ribonuclease was used. This zone appears to correspond to an increase in ribonucleic acid synthesis, as seems indicated by preliminary determinations on egg homogenates. This synthesis of ribonucleic acid induced *in vivo* by reduced ribonuclease is probably the first step in its antimitotic action. This action seems to be related to a modification of the process by which the cytoplasm assumed a gel form and which interferes with the normal formation of the segmentation furrows.

Summarizing, ribonuclease in its reduced form is a very potent antimitotic agent. Both oxidized and reduced enzymes diffuse easily through the cellular membranes of amphibian eggs. Reduced ribonuclease seems to induce a synthesis of ribonucleic acid during its diffusion, and this substance is probably related to the inhibition of segmentation.

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Breeding of the Tree Shrew

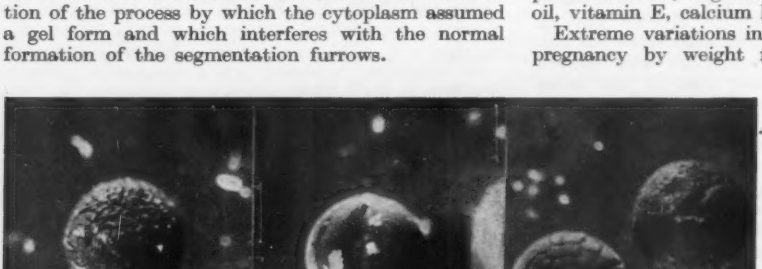
A colony of tree shrews, *Tupaia glis* (Diard), has been maintained at the University of Malaya for the past nineteen months, specimens having been obtained both from the Federation of Malaya and from Thailand. A total of fifty-five living animals has been received; the colony at the time of writing includes thirteen males and fourteen females. After heavy mortality in the early stages of the work, the death-rate dropped to a point where most of those animals surviving the first three months tend to live for at least a year.

Most of the animals are kept in compound cages consisting of six three-foot cubical units, but some are kept in a large outdoor cage of 1,280 cu. ft. capacity. The large cage is heavily planted with shrubs and vines.

The natural diet of *Tupaia* apparently includes a preponderance of insects, supplemented by soft fruits. The present diet includes fruits such as banana and papaya, and an 'insect substitute' mixture containing high-protein cereal, beef extract, honey, fresh eggs, powdered milk, dog biscuits for roughage, cod liver oil, vitamin E, calcium lactate and salt.

Extreme variations in weight obscure evidence of pregnancy by weight records until the last two weeks of pregnancy. Delicate abdominal palpation has often proved satisfactory in indicating pregnancy at an early stage. The animals are highly nervous, however, and require delicate handling.

In no case has it been possible to keep two male tree shrews in the same cage. A male and one or more non-pregnant females live in reasonable harmony, a female being dominant despite her smaller size. Pregnancy has produced marked anti-social aggressiveness in the females observed.



(1) (2) (3)

Embryos at the 2-blastomere stage injected with: (1) oxidized ribonuclease (10^{-12} mol.); (2) reduced ribonuclease (10^{-21} mol.); (3) reduced ribonuclease (10^{-17} mol.)

An aggressive attitude towards another individual, once begun, seems to remain fixed, and will lead to a fatal feud unless the animals are separated. Fighting occurs just as frequently in the large as in the small cages.

Copulation, first observed in January of this year, occurred with increasing frequency during February and March and declined through April and May. Nineteen out of twenty-four females were observed to copulate at least once; eight became palpably pregnant, some individuals more than once, with thirteen pregnancies in all. All but one of the pregnant females either aborted or killed and ate their young the night they were born. The exception (*Tf*39) has given birth twice; the first pair of young was neglected and was found dead and trampled in the nest box litter four days after birth; the second pair was eaten by the mother on the third day. *Tf*39 became pregnant a third time but aborted or resorbed the embryos at about half term.

There is no indication of male sterility, all males appearing sexually vigorous. The females appear to suffer from some factor or factors antipathetic to reproduction manifested by refusal to mate, sterility, spontaneous abortion, litter killing, and neglect of the young. In no case has there been any record of enlargement of mammary glands in pregnant females; the single case of neglect of the young may have been due to milk failure.

The gestation period for *Tupaia glis*, as indicated by the records to date, is between 46 and 50 days. Of six pregnancies for which the number of embryos is certain, there were twins in five cases and a single young in the sixth. (These records include autopsies on three pregnant newly captured females which were received dead.)

Female *Tf*39 showed what I interpret as post partum heat; she achieved a fertile mating between 48 and 72 hr. after parturition.

Observations to date indicate that male sexual aggressiveness is stimulated by female secretions and that the female goes through a socio-psychological pattern similar to that of heat in non-primates.

Cases of intra-uterine bleeding suggestive of menstruation are being investigated at present.

Acknowledgment is due to the Institute for Medical Research, Kuala Lumpur, Malaya, and to the U.S. Army Medical Research Unit in South-East Asia for supply of Malayan specimens and for financial aid in obtaining animals from Thailand respectively. Both bodies are interested in breeding of tree shrews as laboratory hosts of primate virus diseases. The study is proceeding, and I would welcome communication from interested workers.

Note added in proof, Sept. 29. A litter of two born on August 20 is now being weaned.

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Attempts at Nitrogen Fixation *in vitro*

The low activation energies generally associated with free-radical reactions have prompted several workers to explain the high velocity of various biological processes[1,2], including nitrogen fixation[3,4], by mechanisms involving free radicals. Burris's fixation mechanism[3] postulated an enzyme–hydrogen peroxide complex and reduction or oxidation of molecular nitrogen by the free radical $A_h.H^{\cdot}$ or $A_o.(OH)^{\cdot}$, respectively, in the latter case producing $N_2(OH)_2$. Pethica *et al.*[4] suggested that nitrogenase, like catalase[5] and methæmoglobin[6], functions by way of a ferrous–ferric couple activated (as in Fenton's reagent) by hydrogen peroxide, which they regarded as an intermediate in respiration. The link between respiration and fixation could be hydroxyl radicals which reacted with nitrogen to form $N_2(OH)_2$.

Attempts were made, using the isotopic technique, to detect *in vitro* fixation by cell-free extracts from *Azotobacter vinelandii* in the presence of free hydrogen and hydroxyl radicals. Extracts from vigorous cultures were prepared by grinding centrifuged and washed cells with powdered 'Pyrex' glass and phosphate buffer solution (*p*H 7·0) at − 2° C.; the paste was spun out and the supernatant used immediately. An atmosphere of oxygen and heavy nitrogen was circulated by means of the apparatus previously described[3,8] through various solutions in the culture flasks for five hours. In case oxygen gas, some constituent of the medium[3], or free radicals were necessary before nitrogenase could function, these were supplied, singly and together. Hydrogen and hydroxyl radicals, which would according to Pethica be supplied *in vivo* by the respiratory system, were generated *in vitro* by reaction between *M* ferrous sulphate and *M*/2 hydrogen peroxide (inhibitor-free), one drop of each being added every five seconds throughout the experiment.

No shift in the abundance ratios of the atmosphere was observed in any experiment, nor were any gas samples obtained from the various solutions by the Kjeldahl digestion process[3]. In five hours, the equivalent of eighty litres of labelled atmosphere, containing 26·0 atom per cent excess nitrogen-15, passed through each solution, so that it is clear that no fixation of nitrogen is possible under the conditions described. It may be that nitrogenase does not survive the extraction, or must be augmented in some way not at present understood. It is of interest that nitrogen can be fixed in aqueous solution by an electric discharge. Campardou[9] gives the equations:

$$N_2 + 2H_2O \rightarrow NH_4NO_2$$
$$NH_4NO_2 + \tfrac{1}{2}O_2 \rightarrow NH_4NO_3$$

and observes that the net reaction uses nitrogen and oxygen in the exact proportion in which they dissolve in water at one atmosphere pressure. However, the results above, together with failure[8,10] to demonstrate the importance of compounds of formula $N_2(OH)_2$ (which is common to the different free radical postulates), constitute strong experimental evidence against such postulates.

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A Quantitative Biological Test Sensitive to Low Doses of Ionizing Radiations

THE important linear dose-effect relationship which is observed in the induction of mutations with ionizing radiations and which has been verified down to 25 r. has not been satisfactorily investigated below this value[1].

Owing to the existence of the 'induction' phenomenon, lysogenic bacteria may be used to demonstrate this relationship within a wide range of doses, including doses as low as 1 rep. The virus in such bacteria is in a masked state, the prophage, which is included in the genetic pattern. Its induction may be considered as a lethal mutation. That some radiations 'induce' the development of phage in lysogenic bacteria was discovered by Lwoff, Siminovitch and Kjelgaard[2] using ultra-violet radiations (2537 A.) and was later shown by Latarjet[3] to occur with X-rays. A bacterium 'induced' with X-rays bursts after a latent period, the length of which depends on physiological conditions, and liberates an average of 100–200 virus particles into the medium. By determining the number of free phages in an induced culture, it is possible to determine how many bacteria have been induced.

The strain utilized here is the lysogenic *E. coli* *K*.12(λ) cultured in 'Difco' tryptone broth. After induction with X-rays, the latent period is 55 min.; that is, after this delay, the first bacteria burst. However, the majority lyse between the 65th and 80th minutes. Both the latent period and the burst size (average number of phage particles liberated per bacterium) are independent of the dose.

In a non-irradiated growing culture of *K*.12(λ) one finds, owing to spontaneous bursts, about one phage per 200 bacteria. This figure corresponds to about 10^{-5} to 10^{-4} spontaneously 'induced' bacteria per generation time. After induction by X-rays, the number of free virus particles increases proportionally to the number of induced bacteria. By measuring the increase in frequency of free phage in the medium, the number of induced bacteria may be estimated.

In an irradiated sample the total number of free phages, N_r, is equal to the sum of the phages produced by induction, N_i, and those arising spontaneously, N_s. For the most accurate determination of N_r it is necessary to have N_s as small as possible. This condition is automatically fulfilled for high doses (more than 50 rep.), but for low doses N_s must be diminished. This may be done without appreciably affecting N_i owing to the fact that the large majority of N_i appear between the 65th and the 80th minute. N_s may be inhibited by adding anti-λ serum before the 65th minute and then suppressing the action of the serum by dilution.

The following experimental technique is used. Samples of a culture of *E. coli* *K*.12(λ) in tryptone broth containing 2×10^9 bacteria/c.c. are diluted tenfold in broth at 0° C. and irradiated. Aliquots of 1 c.c. are taken and kept at 37° for 55 min. At the end of this time, 0·05 c.c. of anti-λ serum is added. At this concentration the serum inactivates 90 per cent of a phage suspension in 5 min. at 37°. The serum is allowed to act for 10 min. and then diluted 100-fold in broth in order to stop its action.

The samples are then incubated for 10 min. at 37°. During this time N_s in the control increases to one-tenth of the initial value, while nearly all the phages arising from induction are liberated. At the 75th minute the bacteria are killed by the chloroform technique[4] and the free phages are titrated. Contrary to *T*2, λ is partly inactivated by this treatment, but since inactivation is the same for every sample the results are unaffected. The titration of the free phage is made using *K*.12S/Str. (streptomycin-resistant) as the indicator strain in the presence of 200 γ of streptomycin to prevent contamination. The plaques are counted after 18 hr. incubation at 37°.

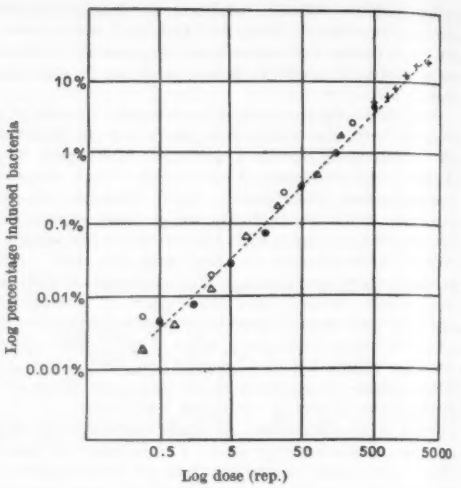

Fig. 1

The source of X-rays is a Holweck tube with a molybdenum target which operates at 37 kV. giving an average wave-length of 0·9 A.

With doses greater than 500 rep. the technique described above (free phage technique) is unnecessary. If the bacteria are plated immediately after irradiation (direct method) each induced bacterium gives one plaque and the percentage of induction may be calculated directly.

In the free phage technique the relationship between the ratio N_i/N_s and the radiation dosage is linear. The slope of this straight line is the same as that of the straight line obtained by the direct method which relates percentage of induced bacteria to dose (see Fig. 1). The two straight lines are brought into conjunction by determining for the same dose (500 rep.) the percentage induction by the direct method and the ratio N_i/N_s by the free phage method on the same sample. This procedure gives a constant which is added to log N_i/N_s so that results below 500 rep. may be expressed as percentages. Since in Fig. 1 the abscissæ and ordinates are on the same scale, it may be concluded that the number of induced bacteria is directly proportional to the dose and that, consequently, induction is a single-hit process.

In Table 1 are given the data used to calculate N_i/N_s for the experiment represented in Fig. 1 by circles. A dose of 1·5 rep. produces a significant increase in the number of the plaques.

Table 1

Doses		0·5	1·5	5	15	50	150	500
N_r	697	1,225	1,566	4,120	9,070	33,100	114,000	430,000
N_s								
N_i/N_s		0·75	1·23	4·85	11·95	46·28	161·8	613

On extrapolating the straight line it can be seen that 100 per cent induction corresponds to a dose of about 10,000 rep. On the basis of the target theory, the diameter of the target for induction is therefore of the order of 100 mμ.

The same doses expressed in rep. given as γ-rays of radium or as X-rays of wave-length 0·9 A. produce the same frequency of induction. By using both X- and γ-rays the inducing effect of radiations was found to be independent of intensity over a range of 10^6. The irradiated bacteria and the control may be kept at 0° C. for several hours without affecting the results of the experiment. This permits the study of ionizing radiations produced at some distances from the laboratory. After 24 hr., however, the sensitivity of the test is lower.

The sensitivity of the above test depends on the inactivating power of the antiserum. Since λ is unfortunately a poor antigen, other lysogenic systems are being investigated.

In addition it should be noted that the sensitivity of this method was found to be too low to detect any effect of cosmic rays at sea-level or any naturally occurring ionizing radiation.

I thank Dr. R. Latarjet for his criticisms and suggestions and Miss R. Vayne for technical assistance.

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Paramagnetic Resonance in Carbonaceous Solids

Following the discovery[1,2] of a paramagnetic resonance absorption of high intensity, and narrow width, in charcoals and other low-temperature carbons, a systematic survey of different coal and carbonized coal samples has been undertaken, to determine what factors affect the magnitude of the absorption. The samples were prepared at Leatherhead and the measurements have been made at Southampton using frequencies of 24,000 Mc./s., 9,000 Mc./s. and 40 Mc./s.

The first effect studied was the variation in intensity of the paramagnetic absorption signal with carbonizing temperature, and the results are shown in Fig. 1. Two series of carbonized coals were used, and both gave very similar variations, having a marked maximum at a carbonizing temperature of *c.* 550° C., and then falling sharply to zero. This variation of signal strength with carbonizing temperature has also been found in other specimens, and it seems to be a general feature that the paramagnetic resonance absorption is destroyed once the carbon has been heated above *c.* 650° C. These results seem to confirm the previous suggestion[2] that this type of absorption is not due to conduction electrons such as those found in graphite[3], but rather to unpaired electrons associated with 'broken bonds' or 'free radicals'. We suggest that heating above 650° C. enables these bonds to join with those from neighbouring carbon atoms, the absorption signal being therefore considerably reduced.

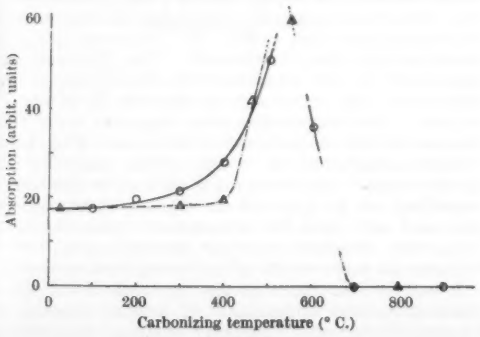

Fig. 1

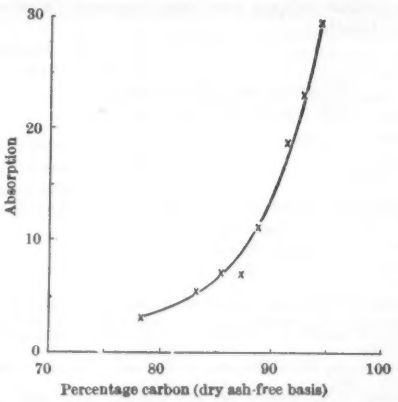

Fig. 2. Absorption of 30 units = $2·5 \times 10^{19}$ free radicals/gm.

The line width and spectroscopic splitting factor remained constant over the whole range of carbonizing temperatures, having values of 8 ± 2 gauss and $2·0030 \pm 0·0003$ respectively. A width of 7 ± 1 gauss was still obtained at 40 Mc./s., which is in striking contrast to the value of 0·1 gauss obtained by Henning *et al.*[4] on graphites at these frequencies, again suggesting that this is an entirely different mechanism from that associated with the conduction electrons. It would appear that variations in width observed in other low-temperature carbons[2] are therefore due to special effects, such as gas adsorption.

An estimate of the number of free radicals present in the carbon was obtained by comparing the intensity of absorption with that from 50 μgm. of diphenyl trinitrophenyl hydrazyl; the results indicated that there are about 3×10^{19} free radicals/gm. in carbons showing the highest absorption (that is, one free radical per 1,600 carbon atoms).

The second effect studied was the variation of absorption intensity of raw coal with its percentage carbon content (rank). These results are shown in Fig. 2. A very sharp increase in the intensity of paramagnetic absorption is observed in coals of rank exceeding 80 per cent carbon content (dry ash-free basis), the intensity at 94 per cent being seven times that at 80 per cent. If the absorption intensity is plotted against the percentage of volatile matter in the coal, an alternative, though less reliable, measure of its rank or maturity, a straight line is obtained.

Since submitting this letter for publication, the work of J. Uebersfeld, A. Étienne and J. Combrisson

on a similar subject has been reported (*Nature*, **174**, 614; 1954).

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Microwave Spectrum of Methyl-Cyanoacetylene

Though methyl-cyanoacetylene (methyl-propiol-nitrile) is a substance of some interest structurally, its preparation has not apparently been described. With the object of studying the microwave spectrum of this substance, we have prepared it by the method used for obtaining higher alkyl-cyanoacetylenes by Grignard and Courtot[1] and Curran and Wenzke[2]. The Grignard reagent, $H_3CCCMgBr$, was treated with cyanogen chloride and a moderate yield of methyl-cyanoacetylene isolated as a colourless, low-melting solid of sweet, penetrating aromatic odour. The best sample obtained to date, by vacuum fractionation, has melting point 16° C., boiling point 101·5° C. (754 mm.) and $n_D^{17°} = 1{\cdot}4342$, but we regard these values as preliminary ones, pending a closer study of possible traces of impurities.

The microwave pure-rotation spectrum of the substance suffices to identify the molecule with certainty. The spectrum is that of a strictly symmetric-top molecule of moment of inertia compatible only with the expected linear arrangement of the nitrogen and carbon atoms on the figure axis. Quadrupole coupling hyperfine structure is also observed, the splitting being that expected for a nitrogen-14 atom located on the figure axis in the group —C≡N; the *iso*cyanide grouping is thus excluded, since it is not expected to give rise to resolvable quadrupole coupling[3]. Measurements have been made on the $J = 5 \rightarrow 6$, $8 \rightarrow 9$ and $10 \rightarrow 11$ transitions, and spectroscopic constants are derived as follows: $B_0 = 2{,}065{\cdot}73$ Mc./s., $D_{JK} = 19{\cdot}8$ kc./s., $D_J = c.\ 0{\cdot}1$ kc./s. and eq$Q$ of $^{14}N = -4{\cdot}4 \pm 0{\cdot}5$ Mc./s. Absorption lines due to molecules in excited bending vibrational states are also observed in the manner expected for this molecule.

The moment of inertia, I_B, derived from B_0 is $406{\cdot}20 \times 10^{-40}$ gm.cm.^{2}, and is in good agreement with the most probable structural parameters. Thus the structure

$$H_3C\underset{1{\cdot}203}{—}C\overset{1{\cdot}458}{\equiv}C\underset{1{\cdot}157}{—}C\overset{1{\cdot}379}{\equiv}N$$

(distances in A.), with $d_{CH} = 1{\cdot}10$ A. and the HCH angle 108° 30′, is in accord with I_B. These parameters are close to those found for analogous bonds in cyanoacetylene[4] and methylacetylene[5]. Methyl-cyanoacetylene has a structure very similar to that of penta-1 : 3-diyne[6], and the values of the distortion constants are very similar for the two molecules.

Further measurements on the fine structure of the spectrum are planned, and it is hoped to evaluate the coupling constant more precisely. Work is also in progress on D_3CCCCN, and we hope later to detect spectra of other isotopic combinations and to determine further details of the structure. We are also investigating the possibility of exchange reactions between the hydrogen atoms and deuterium oxide.

Details will be given in a full report to be published elsewhere.

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L. F. Thomas
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July 14.

[1] Grignard, V., and Courtot, C., *Bull. Soc. Chim.*, **17**, 228 (1915).
[2] Curran, C., and Wenzke, H. H., *J. Amer. Chem. Soc.*, **59**, 943 (1937).
[3] Kessler, M., Ring, H., Trambarulo, R., and Gordy, W., *Phys. Rev.*, **79**, 54 (1950).
[4] Westenberg, A. A., and Wilson, E. B., *J. Amer. Chem. Soc.*, **72**, 199 (1950).
[5] Trambarulo, R., and Gordy, W., *J. Chem. Phys.*, **18**, 1613 (1950).
[6] Heath, G. A., Thomas, L. F., and Sheridan, J., *Nature*, **172**, 771 (1953).

Thunderstorms and Sporadic *E* Ionization of the Ionosphere

In the course of the ionospheric observations carried out at Calcutta (lat. 22° 33′ N., long. 88° 21′ E.) for more than two decades, it had always been found that sporadic E ionization (E_s) is greatly increased during the occurrence of thunderstorms. In view of the persistence of the phenomenon, it was thought worth while to make a close study of the increase of E_s ionization during the occurrence of severe thunderstorms of the squall type, known as 'nor'westers', which are a special feature of the weather of this part of India (Bengal) in the pre-monsoon months March–May. During these thunderstorms the wind generally blows from a north-westerly direction with velocity often exceeding 50 miles/hr. The thunderstorms are invariably accompanied by lightning discharges.

Sporadic E ionization during ten such squalls occurring in the months April–May of 1953 and 1954 has been studied. As the squall was seen to be approaching—indicated by the appearance of the towering cumulo-nimbus clouds—special observation on E_s (besides the usual routine ones) was started and continued until the squall passed over. The observation consisted in gradually increasing the frequency of the transmitter and noting the frequency (fE_s) at which the E_s echo disappeared. The E_s's were distinguished by the characteristic fluctuation of the echoes and the simultaneous appearance of the F_2 echoes. The observations were repeated every four minutes during the progress of the squall. Figs. 1 and 2 depict graphically the results of the study for two typical cases. (The meteorological data in the figures regarding the progress of the squall—start, highest gust and end—and the atmospheric pressure variations were obtained from the Meteorological Office, Alipore, six miles south of the ionosphere station.)

It will be seen that with the approach of the squall there is sudden appearance of intense sporadic E ionization over the observing station. fE_s attains values as high as 10 Mc./s., as compared with the

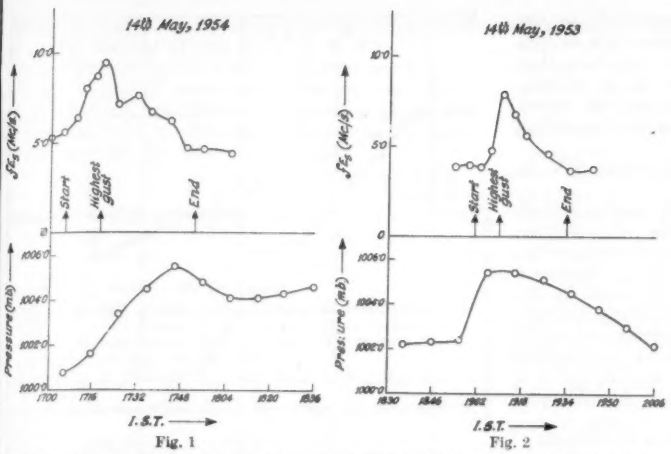

Fig. 1 Fig. 2

Figs. 1 and 2. Increase in the intensity of sporadic E ionization (measured by the penetration frequency fE_s) during the incidence of 'nor'wester' type of severe thunderstorms at Calcutta. The lower curves show the variation of atmospheric pressure during the progress of the storms

average no-storm value of 3·5–5 Mc./s. at this station. It is also to be noted that the development of the sporadic E ionization is such that it attains a maximum soon after the arrival of the squall overhead and decays gradually as the squall moves past the observing station.

The above results strongly suggest that one at least of the causes of sporadic E ionization, the origin of which is still insufficiently understood, is associated with thunderstorms.

The investigations described above form part of the programme of the Radio Research Committee of the Council of Scientific and Industrial Research, Government of India. One of us (M. R. K.) is a research assistant under the Council. We acknowledge the help of Mr. A. K. Saha, research assistant, in making the observations.

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June 24.

Reactions of Molten Salts with Layer-Lattice Silicates

In a study of the reaction of molten salts with layer-lattice silicates, it has been found that treatment of muscovite less than 5 μ equivalent spherical diameter in size with molten lithium nitrate removes a large portion of the potassium from the mica, and lithium is fixed in a not readily exchangeable manner. When saturated with barium and glycerol-solvated, the material gives a 001 spacing of 17·8 A., the basal spacing for glycerol montmorillonoids. The intensity of the 17·8 A. line with respect to the 10 A. mica line varies with the muscovite/lithium nitrate ratio and the length of treatment. The muscovite was obtained by fractionation of delamica, a finely divided muscovite separated from Cornish china clay and containing a small amount of kaolinite.

As an example of the action of molten lithium nitrate on muscovite, the chemical composition of the treated and untreated material from one experiment is shown in Table 1. The 1–0·2 equivalent spherical diameter fraction of muscovite was heated with 60 parts by weight of lithium nitrate at 300° C. for 18 hr., washed free of excess salt and saturated with calcium by seven washings with 1 N calcium chloride, and total potassium and lithium determined with an Eel flame photometer.

Theoretically, muscovite should contain 250 milliequivalents of potassium per 100 gm. The negative charge equivalent to this presumably arises from substitution of Al^{3+} for Si^{4+} in tetrahedral co-ordination. If potassium is replaced by cation exchange or the negative charge on the layer decreased internally by penetration of lithium into the structure, the summation of milliequivalents of potassium, lithium and cation exchange capacity should be constant. The equivalences by Table 1 are a general feature of all treatments analysed. The experimentally determined cation exchange capacity is in good agreement with the difference $250 - \Sigma K^+,Li^+$. These equivalences suggest the following mechanism: lithium replaces potassium, then enters the lattice and reduces the charge on the lattice, which renders it expandable.

The X-ray diffraction pattern of a glycerol-solvated specimen of the untreated muscovite showed no trace of any expanding material. When the lithium-treated muscovite was saturated with barium and glycerol-solvated, it showed a rational series of reflexions corresponding to a d_{001} of 17·8 A. on X-ray analysis.

Removal of potassium from muscovite by molten lithium nitrate proceeded quite rapidly in the case of the 1–0·2 μ fraction until the concentration of potassium in the melt reached a value of approximately 0·05 N. Treatment of muscovite with a melt of lithium nitrate having a potassium concentration of 0·05 N resulted in almost complete inhibition of the reaction.

Other dioctahedral micas, including an illite from Fithian, Illinois, a micaceous sub-soil clay on basement Carboniferous sandstone from North Wales, and paragonite reacted in a manner similar to the muscovite. Biotite, a trioctahedral mica, was not expanded by treatment with molten lithium nitrate.

Hofmann and Klemen[1], in explaining the irreversible loss of surface on heating of lithium-montmorillonite, suggested that lithium ions migrated into the vacant octahedral positions with a consequent neutralization of charge. The present work

Table 1. Chemical Composition of Treated and Untreated Muscovite of 1–0·2 μ Equivalent Spherical Diameter

	Potassium ions	Lithium ions	Cation exchange capacity	$\Sigma K^+,Li^+$, cation exchange capacity
	(milliequivalents per 100 gm.)			
Untreated	223	15	15	253
Treated	63	94	92	249

shows the lithium ions to be very firmly held by the dioctahedral layer silicates on treatment with molten lithium nitrate, and although it does not show that they enter octahedral co-ordination, it is unlikely that the lithium could be fixed between the layers or on accessible surfaces in such readily expanding material.

A more detailed account of this work will be published elsewhere.

Grateful acknowledgment is made to the British Museum (Natural History) for gifts of minerals. I wish to thank George Brown for his encouragement and general assistance and Dr. D. M. C. MacEwan for his interest and the invitation to work in the X-Ray Section of the Rothamsted Pedology Department. The investigation was undertaken while on sabbatical leave from the Purdue University Agronomy Department and during the tenure of a National Research Council (U.S.A.) Postdoctoral Fellowship.

Joe L. White

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June 30.

[1] Hofmann, U., and Klemen, R., *Z. anorg. Chem.*, **262**, 95 (1950).

Conductivity induced in Polystyrene by X-Rays

A long time-constant of recovery for the conductivity induced by X-rays in a polystyrene-insulated condenser was observed by one of us (F. T. F.) in 1942 [1]. We have recently made further measurements on polystyrene, using the d.c. amplifier technique with the insulating specimen in an evacuated chamber, as previously described[2,3]. The dependence upon temperature and dose-rate of the induced conductivity both during and after irradiation have been investigated.

These experiments have confirmed the long time-constant, which is comparable with those observed in polythene[3] and polytetrafluorethylene[4]. The magnitude of the induced current, however, is smaller than in the two latter materials, being in fact of the same order as that in 'Perspex' or some types of amber.

Dose-rate dependence. In the relationship between induced current i and dose-rate R,

$$i \propto R^{\Delta}, \qquad (1)$$

we find $\Delta = 0{\cdot}6 \pm 0{\cdot}1$ for polystyrene over the range $R = 2$–64 r./min., and between 20° C. and 110° C. Using Rose's model of photoconducting insulators[5], this value of Δ leads us to postulate an exponential distribution of trapping-levels below the conduction band. A consequence of this model is that when Δ is close to $\frac{1}{2}$, the variation of Δ with temperature should be large enough to be observed. This is in fact found to be so, Δ having the higher values at the lower temperatures, as in the case of polytetrafluorethylene[4].

Temperature dependence. Fig. 1 shows the graphs of log (conductivity) of polystyrene plotted against the reciprocal of absolute temperature. The resulting straight lines are of slope proportional to the activation energy, according to the general formula

$$\sigma = \sigma_0 \exp(-W/kT). \qquad (2)$$

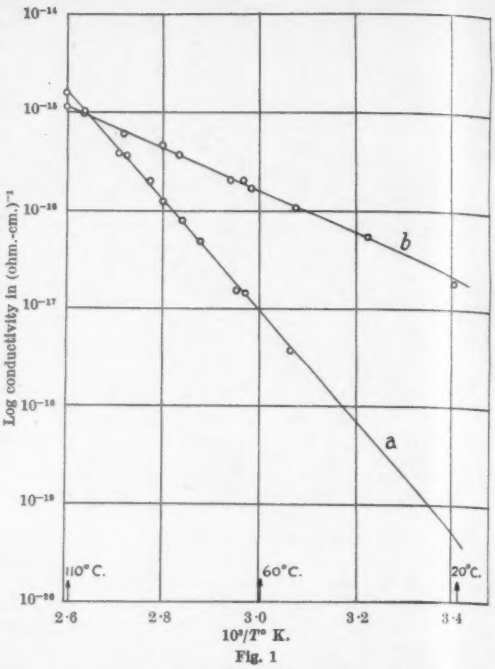

Fig. 1

In the case of static conductivity (that is, no incident radiation; Fig. 1*a*), $W = 1{\cdot}2$ eV. For the equilibrium induced conductivity under X-irradiation (Fig. 1*b*) at $R = 7$ r./min., the slope corresponds to $W = 0{\cdot}44$ eV.

From the latter graph it can be seen that the induced current increases by a factor of 60 between 300° K. and 400° K. The corresponding increase predicted using the model of an exponential distribution of traps is by a factor of 80, if we assume a value of $N_c = 10^{19}$ for the number of available energy-levels in the lowest part of the conduction band a few kT wide. The agreement is fairly satisfactory, and shows that a slightly lower value of N_c would give better agreement, as in the case of polythene and polytetrafluorethylene.

Decay of induced current. The time-constant of decay varies slowly with temperature, showing the same general features that we have described for polythene and polytetrafluorethylene: at temperatures below 70° C. the current falls at first more rapidly, but after a few minutes more slowly than at higher temperatures, so that complete decay takes longer at the lower temperatures. The current remaining after a few minutes is proportional to 1/time, as for polythene and polytetrafluorethylene. The time-constant decreases with increasing dose-rate, as expected, and the relationship appears to be reciprocal.

The magnitude of the time-constant is large, being even greater than for polytetrafluorethylene (for which $\Delta = 0{\cdot}63$), and considerably longer than for polythene ($\Delta = 0{\cdot}8$). The following table summarizes the results:

Temperature	Dose-rate	Time to fall to 10 per cent	Time to fall to 1 per cent
100° C.	7 r./min.	1 hr.	6 hr.
20° C.	7 r./min.	½ hr.	12 hr.

These recovery curves are in good agreement with the earlier results[1] of one of us (F. T. F.).

The magnitude of the induced current accords well with the results of Armistead, Pennock and Mead[6], and of Coleman and Bohm[7], if equation (1) is used to extrapolate the present measurements to the higher dose-rates used by them.

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June 25.

[1] Farmer, F. T., *Nature*, 150, 521 (1942).
[2] Fowler, J. F., and Farmer, F. T., *Nature*, 171, 1020 (1953).
[3] Fowler, J. F., and Farmer, F. T., *Nature*, 173, 317 (1954).
[4] Fowler, J. F., and Farmer, F. T., *Nature*, [174, 136 (1954)].
[5] Rose, A., *R.C.A. Rev.*, 12, 362 (1951).
[6] Armistead, F. C., Pennock, J. C., and Mead, L. W., *Phys. Rev.*, 76, 860 (1949).
[7] Coleman, J. H., and Bohm, D., *J. App. Phys.* 24, 497 (1953).

Anomalies in Osmotic Pressure Measurements

In the course of a study of the molecular weights of coal-tar pitch fractions, we have observed unusual anomalies with two samples in benzene solution. A large number of fractions have been examined in benzene and in other solvents using modified Zimm–Meyerson osmometers fitted with specially prepared polyvinyl alcohol membranes[1] of the lowest possible permeability. We and other workers[2] have found samples of average molecular weight as low as 250 to be retained by the membranes, and nearly all our samples have followed van't Hoff's law almost exactly. As the full results of the investigation are being published elsewhere, attention is now directed only to the behaviour of two fractions produced by molecular distillation of that part of a coke-oven tar pitch which is insoluble in petroleum ether of boiling range 100–120° C. but soluble in benzene.

These two samples are believed to consist predominantly of condensed polycyclic aromatic hydrocarbons and to contain also limited quantities of compounds containing oxygen, nitrogen or sulphur in the ring structure or oxygen in phenolic form. Both have a number average molecular weight of about 400. The anomalous behaviour is a marked reduction of the reduced osmotic pressure, when measured at 25° C. in benzene solution, with increasing concentration. In both instances the actual osmotic pressure passed through a maximum and fell again as the concentration was raised. One of the samples was found to yield no detectable pressure at all at a concentration of 0·065 gm. per 100 gm. solvent. The other sample was examined at each of several temperatures in benzene and at 30° C. in nitrobenzene, the results being shown in Fig. 1. The phenomenon tends to disappear at elevated temperatures and does not occur at all in nitrobenzene solution.

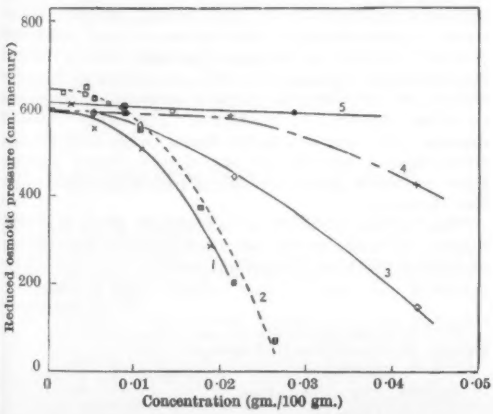

Fig. 1. Reduced osmotic pressure curves for pitch fractions. Curves 1–4, in benzene at 20°, 25°, 30°, 40° C. respectively. Curve 5, in nitrobenzene at 30° C.

At first sight this behaviour seems to be most readily explained by assuming association of the solute molecules in a weak solvent, and the effect of raising the temperature and of changing to the stronger polar solvent seems to support this view. That association should occur to the extent indicated by the results, however, and at so low a concentration, is difficult to imagine.

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July 12.

[1] Hookway, H. T., and Townsend, R., *J. Chem. Soc.*, 3190 (1952).
[2] Report of the Chemistry Research Board for 1953, 48 (H.M Stationery Office, London, 1954).

Structural Changes in Boiling Solutions of Sugar with Reference to Chromatography of Carbohydrates

The sensitivity of the chromatographic method in detecting sugars has made possible a greater appreciation of the labile character of many monosaccharides, and has emphasized the significance, in quantitative work, of degradation in sugar solutions at the boil[1] and of accelerated epimerization attributable to trace alkalis in chromatographic paper[2]. It does not seem to be so fully appreciated, however, that structural changes in sugar solutions can occur during heating for periods comparable with those frequently used in polysaccharide hydrolyses, and that such changes might give rise to misinterpretation of the results of qualitative paper-chromatography studies.

The effect referred to may be illustrated by the chromatograms reproduced in Fig. 1, which were obtained by applying the appropriate syrups to the paper without heat-drying, developing with butanol/acetic acid/water solvent, and spraying with aniline hydrogen phthalate. The hydrolysate of the water-soluble fraction of chlorite-treated *Urena lobata* fibre, after neutralization and concentration to a syrup at 50° C., was applied, without heating, along a line on a sheet of filter-paper. A spot of the syrup was used to indicate the positions of the separated fractions in the main chromatogram (Fig. 1,*a*). Half the section of the paper which contained the rhamnose fraction of the hydrolysate was extracted with distilled water in a micro-Soxhlet apparatus, and the solution in the flask was maintained at the boil for 12 hr., a period in excess of that required for complete extraction, yet considerably less than many hydrolysis-times quoted in the literature. On chromatographic development the concentrated solution yielded not only a spot corresponding to rhamnose but also another spot for a sugar with an R_G value approximating to that of xylose (Fig. 1,*b*). The other half of the section of the paper, with the remainder of

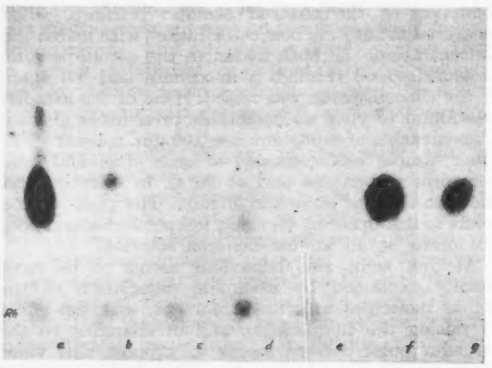

Fig. 1. Chromatograms illustrating the effect of heating sugar solutions. (*a*) Hydrolysate from *Urena lobata*; (*b*) rhamnose fraction of the hydrolysate after boiling; (*c*) rhamnose fraction from the hydrolysate eluted with cold water; (*d*) pure rhamnose solution after boiling; (*e*) pure rhamnose; (*f*) pure xylose solution after boiling; (*g*) pure xylose

the rhamnose separated out from the main hydrolysate, was eluted with cold distilled water, and the resultant chromatogram (Fig. 1,*c*), obtained as usual, showed only the single spot corresponding to rhamnose. Thus it would appear that the rhamnose isolated from the fibre hydrolysate was uncontaminated by other sugars, and that epimerization or other structural change had occurred by and during the heating of the aqueous solution. It seemed scarcely feasible that alkaline conditions could have arisen either from the glassware, which was of well-used 'Pyrex', or from the filter-paper, in view of the acidity of the solvent used. Confirmation that structural transformation occurs on heating rhamnose in non-alkaline solution was obtained by refluxing a solution of chromatographically pure rhamnose (Fig. 1,*d*) in distilled water for 12 hr., during which period the *p*H of the solution fell to a value of 3·9 (Fig. 1,*e*).

The conversions occurring are not confined to the methyl pentose, since xylose solution, which yielded a single spot on a chromatogram (Fig. 1,*g*), showed additional spots after boiling for 12 hr. (Fig. 1,*f*).

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Dundee. July 8.

[1] Laidlaw, R. A., and Reid, S. G., *Nature*, **166**, 476 (1950).
[2] Duff, R. B., *Chem. and Indust.*, 898 (1953).

Effect of Chelating Agents on Heavy Metal Catalysis

In a recent communication, Pirie and Van Heyningen[1] have reported "a case where a chelating agent accelerated the oxidation of a substance (glutathione), which it was intended to preserve in the reduced state"[1]. The object of the chelating agent was "the removal of metals", traces of which would presumably catalyse the oxidation. Since chelating agents are being generally used for this purpose, it seems worth while emphasizing that the metal chelate complexes formed are not necessarily without catalytic activity. Thus 1 : 10 phenanthroline, $\alpha\alpha'$di-pyridyl and $\alpha\alpha'\alpha''$tripyridyl increase the iron-catalysed rate of decomposition of hydrogen peroxide by as much as one hundred-fold[2], and certain hæmoprotein complexes of iron are well known as catalysts in biological systems.

We are studying the effect of chelating agents on the metal-catalysed autoxidation of *cyclo*hexene. Only in the case of copper has the metal chelate complex been found to be catalytically inactive. In the case of iron, the formation of the chelate complex greatly increased the rate of the reaction. Approximate results are quoted in the table for the reaction at 60° C. in the presence and absence of 2 gm. mol. of NN′disalicylidene ethylene diamine per gm. mol. of the metal heptoate.

Metal, initial valency state and concentration	Extent of oxidation after 60 min. reaction (gm. oxygen/kgm. *cyclo*hexene)	
	No chelating agent	Disalicylidene ethylene diamine present
Cu^{II} 50 p.p.m.	13	0·12
Fe^{III} 500 p.p.m.	1·3	*c.* 50
Mn^{II} 49·5 p.p.m.	21*	25
Co^{II} 49·1 p.p.m.	27	36*
Metals absent	0·12	0·12

* Durations of these reactions are taken as 60 min. from the termination of the induction periods.

The formation of the chelate complex has little effect on the manganese-catalysed reaction. The kinetic characters of the two cobalt-catalysed reactions are completely different, however. In the absence of disalicylidene ethylene diamine the rate decreases, but in its presence the rate increases during the initial course of the reaction. The effect of a chelating agent sequestering copper but 'vivating' iron has also been established by us for the autoxidation of *cyclo*hexene in the presence of NN′di*cyclo*hexyldithiooxamide. Further, we have observed a similar phenomenon for the autoxidation of sodium sulphite in aqueous solution, thus indicating that it is by no means confined to non-aqueous media.

The foregoing results show that not only metal ions but also covalently bound metals can be effective catalysts for free-radical chain-reactions. The fact that copper catalysis is prevented by chelation may result from the special condition that cuprous–cupric transitions probably involve large free energies of activation when the metal is chelated. Both cuprous and cupric copper have a normal co-ordination number of four, but the former requires a tetrahedral and the latter a planar disposition. Iron, however, will co-ordinate octahedrally in both valency states. Moreover, a quadridentate chelating agent may sterically prevent reaction in the case of a metal with a normal co-ordination number of four if the electron transfer mechanism requires the reacting molecule to enter the co-ordination shell of the metal. The study of hexadentate chelating agents for metals with a maximum co-ordination number of six should throw further light on these possibilities. Work is continuing in this direction.

This communication is published with the permission of the Council of the Research Association of British Rubber Manufacturers.

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J. F. Smith

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Shrewsbury, Shropshire.
June 17.

[1] Pirie, A., and Van Heyningen, R., *Nature*, **173**, 873 (1954).
[2] Baxendale, J. H., "Advances in Catalysis", **4**, 62 (1952).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 25

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. A. F. W. Hughes: "Some Aspects of the History of Microscopy".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Whether Compatibility is Necessary for a Colour Television System in Great Britain".

Tuesday, October 26

SOCIETY FOR APPLIED BACTERIOLOGY (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 3 p.m.—Discussion on "Recent Advances in the Bacteriology of Milk and Milk Products".

Wednesday, October 27

UNIVERSITY COLLEGE, LONDON (in the Gustave Tuck Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. D. Strömbäck (Uppsala): "The Academic Approach to Folk-Lore Studies". (From a series of lectures on "Folk-Lore".)*

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6 p.m.—Annual General Meeting. Rear Admiral (L) Sir Philip Clarke: Presidential Address.

INSTITUTION OF MECHANICAL ENGINEERS, EDUCATION GROUP (at Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Units of Measurement of Length, Mass and Force Employed in the Teaching of Applied Mechanics and General Mechanical Engineering Subjects".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 7.45 p.m.—Dr. Cudjoe: "Ewe Folk-Tales, Children's Games, Drumming and Dancing". Leader: Mr. Desmond Tay.*

Thursday, October 28

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Hannah Steinberg: "Drugs and Psychological Tests".*

Thursday, October 28—Friday, October 29

INSTITUTE OF PETROLEUM, SPECTROSCOPIC PANEL of the HYDROCARBON RESEARCH GROUP (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2)—Conference on "Molecular Spectroscopy".

Friday, October 29

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting. Mr. D. H. Sadler: "The Role of the Institute" (Presidential Address).

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. F. Dollin: "Factors Influencing the Continuing Development of the Steam Turbine" (Nineteenth Parsons Memorial Lecture).

INSTITUTE OF PHYSICS, NON-DESTRUCTIVE TESTING GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. W. G. Cook: "Jet Engines and Non-Destructive Testing".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Dr. L. Harrison Matthews, F.R.S.: "Animal Life in the Antarctic".

Saturday, October 30

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. H. J. Braunholtz: "The Potter's Craft in Africa".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL (with appropriate agricultural qualifications, together with experience in teaching, administration and practical farming) OF THE YORKSHIRE INSTITUTE OF AGRICULTURE, Askham Bryan, near York—The Chief Education Officer, County Hall, Wakefield (October 28).

SCIENTISTS (with a first- or good second-class honours degree in physics, engineering, mathematics or statistics, and experience in field, laboratory or operational research), in the FIELD INVESTIGATION GROUP, to carry out field work at collieries—National Coal Board, Establishments (Personnel), Hobart House, London, S.W.1, quoting PT/852 (October 30).

LECTURER (graduate in chemical engineering or graduate in chemistry with postgraduate training and/or experience in chemical engineering) IN CHEMICAL ENGINEERING—The Principal, Manchester Municipal College of Technology, Manchester (November 1).

RESEARCH FELLOWS (2) (one with at least a second-class honours degree in physics, chemical or mechanical engineering, and the other with at least a second-class honours degree in mechanical engineering or physics) IN THE DEPARTMENT OF TEXTILE INDUSTRIES—The Registrar, The University, Leeds (November 1).

ASSISTANT LECTURER (with a university degree in engineering or equivalent, and preferably with some industrial experience) in GENERAL ENGINEERING SUBJECTS—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (November 2).

ASSISTANT LECTURER IN PURE MATHEMATICS—The Registrar, The University, Sheffield (November 6).

CHEMICAL ENGINEER or CHEMIST (with a good honours degree in chemistry or A.M.I.Chem.E., and with previous industrial experience), at the Divisional Laboratory, National Coal Board, Edgbaston, Birmingham, for investigations into the treatment and disposal of mine water effluents—The Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Worcestershire (November 6).

BIOMETRICIAN (with a good degree in mathematical statistics, and a wide experience in the design and analysis of field experiments in all branches of agricultural and animal husbandry research); a FISHERIES OFFICER (graduate in natural science, and preferably with specialization in zoology, and with subsidiary knowledge of physiology and chemistry); a DAIRY OFFICER (graduate in dairying or agriculture, and with experience in the administration of milk recording schemes); a SYSTEMATIC BOTANIST (graduate in botany and preferably with experience in herbarium work); and an ANIMAL HUSBANDRY OFFICER (graduate in agriculture with specialization in animal husbandry), in the Department of Research and Specialist Services, Federal Ministry of Agriculture, Federation of Rhodesia and Nyasaland—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (November 10).

TECHNICAL OFFICER, Grade II (with good general training in chemistry, preferably up to degree standard, and experience in fuel technology and fuel analysis) in the COAL SURVEY LABORATORY, Leeds—National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/856 (November 10).

ASSISTANT LECTURER (Botany), and a DEMONSTRATOR (Zoology) in the BIOLOGY DEPARTMENT—The Registrar, University College of North Staffordshire, Keele, Staffs (November 13).

CEREAL TECHNICIAN (with a sound knowledge of wheats and milling technique, and City and Guilds of London certificate or equivalent qualifications) at the Agricultural Research Institute, New South Wales Department of Agriculture, Wagga, Australia, to be fully responsible for the preparation, appraisal and milling of wheat on Allis Chalmers test mill, and maintenance of plant—The Agent General for New South Wales, 56 Strand, London, W.C.2 (November 15).

LECTURER IN CIVIL ENGINEERING at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, November 15).

LECTURER (with a university degree in mechanical engineering) IN MECHANICAL ENGINEERING at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 22).

LECTURER IN APPLIED AND INDUSTRIAL CHEMISTRY at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 25). (Additional copy to The Registrar, University of Cape Town, Private Bag, Rondebosch, C.P., South Africa (November 30).

LECTURER (with good experience in different types of educational posts, and preferably with ability to specialize in methods in teaching science) IN EDUCATION at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hong Kong, November 30).

PROFESSOR (with a higher degree, teaching experience at university level and with research experience in at least one of the more important fields of psychology) OF PSYCHOLOGY, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, November 30).

AGRICULTURAL ECONOMIST (graduate in economics and/or agriculture, and with some postgraduate experience in agricultural economics), in the Department of Agricultural Economics, School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

ASSISTANT (graduate in metallurgy, chemistry or physics, and preferably with foreign language knowledge), for abstracting, translating, literature searching, indexing and editorial work—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

CHEMISTS or ENGINEERS (with an honours degree in science or engineering, or Corporate Membership of a recognized professional institution, and with varied scientific experience in industry or a research establishment) at Risley, to serve in a headquarters section whose function is the co-ordination and control of a group of laboratories—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 688.

ELECTRICAL ENGINEERS and PHYSICISTS (with a first- or second-class honours degree or equivalent in physics or light electrical engineering) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work on radio and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.267/54A.

ENGINEER or CHEMIST, Grade I (with an honours degree in engineering or science or Corporate Membership of a recognized professional institution, and with wide and varied engineering or scientific experience, and preferably with experience in programme planning, cost control, staff management, etc.), to take charge of a headquarters section responsible for co-ordinating activities of a group of research and development laboratories—United Kingdom Atomic Energy

Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 686.

Engineers and Physicists, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree or equivalent high professional attainments), in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52A.

Geologist (with a degree in science with geology as a major subject, or equivalent, and preferably with experience of economic geology) in the Mines Department of South Australia—The Agent General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1.

Junior Investigator (Research Officer grade) (with a degree in metallurgy or equivalent qualifications), to undertake research work on the welding of aluminium alloys and special materials; and a Laboratory Assistant (Research Assistant grade), to undertake metallographic work and testing as a member of a research team—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

Keeper (with practical experience in a herbarium and ability to organize and direct technical staff, and preferably with a science degree and a fundamental knowledge of taxonomic botany) of the Herbarium (Botanic Garden), Adelaide, South Australia—The Agent General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1.

Master or Mistress to teach Biology throughout the school to university entrance standard—The Headmaster, Keswick School, School House, Keswick.

Microbiologist (preferably with medical qualifications and some experience of clinical bacteriology and virus work), for research on aetiology of non-specific urethritis—Prof. A. A. Miles, Lister Institute, Chelsea Bridge Road, London, S.W.1.

Organic Chemists (Ph.D. or equivalent experience) to continue research on the degradation of carbohydrates—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

Photographic Technician (with good training in photographic methods, and preferably with some experience in medical work)—The Secretary, Royal Free Hospital School of Medicine, Hunter Street, London, W.C.1.

Physicist (with a good honours degree and preferably some research experience), to undertake research on the shrinkage and dimensional stability of fabrics—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

Scientific Assistant (with a university degree, a knowledge of at least two European languages and ability to write clear, concise English), for duties which include abstracting world scientific literature on animal breeding, genetics and production—The Director, Commonwealth Bureau of Animal Breeding and Genetics, King's Buildings, Edinburgh 9.

Senior Experimental Officer or Experimental Officer (with higher school certificate (science) or equivalent), to assist in a chemical engineering branch, in the compilation of detailed flowsheets, design calculations, and plant specifications, required for the engineering design branch for new chemical plant and equipment—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 519/WGE/2.

Technician in the Department of Chemical Engineering to assist in preparation of Co-enzyme "A"—The Secretary, University College, Gower Street, London, W.C.1, quoting Chem.Eng./2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Excerpts from the speech of Academician Imre Nagy, Chairman of the Council of Ministers of the Hungarian People's Republic, at the General Assembly of the Hungarian Academy of Sciences on June 14, 1954. Pp. 14. (London: Hungarian News and Information Service (Hungarian Bulletin), 1954.) [98

Report by the Hydrographer of the Navy on the Surveys carried out by H.M. Naval Surveying Service, and of the work of the Hydrographic Department, for the year 1953. Pp. 10. (London: Admiralty, Hydrographic Department, 1954.) [98

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 18, No. 3: Report on Research from the *Ernest Holt* into the fishery near Bear Island, 1949 and 1950. By Michael Graham, G. C. Trout, R. J. H. Beverton, John Corlett, A. J. Lee and R. W. Blacker. Pp. 88+4 plates. (London: H.M. Stationery Office, 1954.) 12*s*. 6*d*. net. [98

Speeches at the dinner in honour of General Alfred M. Gruenther under the auspices of the English-Speaking Union of the Commonwealth, June 8, 1954. With an Introductory Note by Lionel Curtis. Pp. 21. (Oxford: Basil Blackwell, 1954.) 6*d*. [98

Report of the Departmental Committee on Foot-and-Mouth Disease, 1952–1954. Pp. 151. (Cmd. 9214.) (London: H.M. Stationery Office, 1954.) 5*s*. 6*d*. net. [128

Annual Report for 1953 (No. 66) of the Marine Biological Station at Port Erin, Isle of Man. Drawn up by J. S. Colman. Pp. 27. (Liverpool: University Press of Liverpool, 1954.) 3*s*. [128

Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing in the University of Leeds, for the Session 1952–53. Pp. 35. (Leeds: The University, 1953.) [128

Building Research Station Digest. No. 68 (July, 1954): Damp-proof Courses. Pp. 5. (London: H.M. Stationery Office, 1954.) 3*d*. net. [128

Colonial Office. The Fertilizer Requirements of the Kenya Highlands: being the Final Report of the Highland Fertilizer Scheme, 1948–1950. By R. V. Holme and E. G. P. Sherwood. (Colonial Research Studies No. 12.) Pp. v+55+xliii. (London: H.M. Stationery Office, 1954.) 10*s*. net. [128

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 921, Vol. 127 (10 August 1954): Crystallization Phenomena in Polymers. 1: Preliminary Investigation of the Crystallization Characteristics of Polyethylene Terephthalate. By A. Keller, G. R. Lester and L. B. Morgan. 2: The Course of the Crystallization. By L. B. Morgan. 3: Effect of Melt Conditions and the Temperature of Crystallization on the Course of the Crystallization in Polyethylene Terephthalate. By F. D. Hartley, F. W. Lord and L. B. Morgan. Pp. 1–34+plates 1–3. 15*s*. 6*d*. No. 922, Vol. 247 (10 August 1954): The Interpretation of the Infrared and Raman Spectra of the *n*-Paraffins. By J. K. Brown, N. Sheppard and Delia M. Simpson. Pp. 35–58. 7*s*. 6*d*. No. 923, Vol. 247 (10 August 1954): The Construction, Operation and Performance of a Primary Standard Mercury Column for the Measurement of High Pressures. By K. E. Bett, P. F. Hayes and D. M. Newitt, F.R.S. Pp. 59–100+plates 4 and 5. 16*s*. 6*d*. (London: Cambridge University Press, 1954.) [128

Other Countries

Carte Géologique du Massif du Mont-Blanc (Partie Française). Mont-Blanc (Sommet). Par MM. Paul Corbin et Nicolas Oulianoff. (Paris: Société Française de Stéréotopographie, 1952.) 1200 francs. [307

Indian Council of Agricultural Research. Science Monograph No. 19: Rice Breeding and Genetics. By K. Ramiah, with the assistance of M. B. V. N. Rao. Pp. x+360+33 plates. (New Delhi: Unesco, South Asia Science Co-operation Office, 1953.) 17 rupees. 8 annas; 27*s*. [307

Sudan Government. Ministry of Agriculture: Forests Department, Report for the period July 1952 to June 1953. Pp. iv+82. (Khartoum: Ministry of Agriculture, 1954.) [98

Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin. Klasse für Mathematik und allgemeine Naturwissenschaften. Jahrgang 1953 Nr. 2: Der Symmetriecharakter des Turbulenz- (Austausch-) Tensors. Von Hans Ertel. Pp. 8. 1 D. mark. Jahrgang 1953 Nr. 4: Statistische Thermodynamik des Vertikalen Temperaturgradienten der Atmosphäre. Von Hans Ertel. Pp. 15. 1 D. mark. Jahrgang 1954 Nr. 2: Ein Theorem Über die Feldstärke in Potentialfeldern. Von Hans Ertel. Pp. 11. 1 D. mark. (Berlin: Akademie-Verlag, 1953 and 1954.) [98

Bulletin of the Seismological Society of America. Vol. 44, No. 2B, April 1954 (Second Part): An Engineering Study of the Southern California Earthquake of July 21, 1952, and Its Aftershocks. By Karl V. Steinbrugge and Donald F. Moran. Pp. ii+201–462. (Berkeley, Calif.: University of California Press, 1954. Published for the Society.) 2 dollars. [98

Smithsonian Miscellaneous Collections. Vol. 122, No. 14: A New Genus and Species of Plankton Diatom from the Florida Straits. By Paul S. Conger. Pp. ii+8+4 plates. (Publication 4171.) (Washington, D.C.: Smithsonian Institution, 1954.) [98

Proceedings of the United States National Museum. Vol. 103, No. 3331: Studies in Neotropical Mallophaga. 11: Bird Lice of the Suborder Amblycera, Genus Dennyus Neumann. By M. A. Carriker, Jr. Pp. 533–550. Vol. 103, No. 3332: Nearctic Flies of the Family Periscelidae (Diptera) and certain Anthomyzidae referred to the Family. By A. H. Sturtevant. Pp. 551–562. Vol. 103, No. 3333: North American Triclad Turbellaria. 13: Three New Cave Planarians. By L. H. Hyman. Pp. 563–574. (Washington, D.C.: Smithsonian Institution: U.S. National Museum, 1954.) [98

Proceedings of the United States National Museum. Vol. 103, No. 3324: Marine Polychaete Worms from Point Barrow, Alaska, with additional records from the North Atlantic. By Marian H. Pettibone. Pp. 203–356. (Washington, D.C.: Smithsonian Institution: U.S. National Museum, 1954.) [98

Salt in the Leeward Islands. By P. H. A. Martin-Kaye. Pp. vi+58. (Antigua: Government Printer, 1954.) 1.40 dollars. [98

New Zealand Forest Service. Forest Research Institute. Technical Paper No. 1 (March, 1954): Heartwood Formation in *Pinus Radiata* D. Don. By J. Maddern Harris. Pp. 31. (Wellington, N.Z.: Government Printer, 1954.) [98

Acta Technica. Academie Scientiarum Hungaricae. Tomus 9, Fasciculi 1–2: The Role of Heterogeneous Swelling in the Formation of Certain Wool Properties. By Prof. M. Zilahi and O. K. Dobozy. Pp. 65–120. (Budapest: Akademiai Kiado, 1954.) [98

The University Teaching of Social Sciences—Political Science. (A Report prepared by William A. Robson on behalf of the International Political Science Association.) Pp. 252. (Paris: Unesco; London: H.M. Stationery Office, 1954.) 1.50 dollars; 8*s*. 6*d*.; 400 French francs. [98

Museums Trustees of Kenya. Coryndon Memorial Museum, Nairobi. Annual Report for 1953. (1) Chairman's Report. (2) Curator's Report. Pp. i+26+2 plates. (Nairobi: Coryndon Memorial Museum, 1954.) 1*s*. [48

Astounding New Discoveries: Thousands of Amazing Facts Discovered Beneath the Very Surface of the Original Bible Text. By Karl Sabiers. Pp. 24. (Sudbury, Ontario: Numerics Unlimited.) [98

World Health Organization. Technical Report Series. No. 77: Expert Committee on Environmental Sanitation. Third Report. Pp. 25. 1*s*. 9*d*.; 0·25 dollars; 1 Swiss franc. No. 80: Expert Committee on Malaria. Fifth Report. Pp. 42. 1*s*. 9*d*.; 0·25 dollars; 1 Swiss franc. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) [98

République Française: Ministère de la France d'Outre-Mer. Reconnaissance Géologique de La Guyane Française Méridionale 1948–1949–1950, précédée d'un aperci géographique. Par E. Aubert de la Rüe. Pp. 128+22 plates. (Paris: Éditions Larose, 1953.) 2500 francs. [98

South Pacific Commission. Technical Paper No. 54: The Pacific Islander and Modern Commerce. By V. D. Stace. Pp. vi+29. (Noumea, New Caledonia: South Pacific Commission, 1954.) 2*s*. [98